# The SEA-LILIES, SEA-STARS, BRITTLE STARS and SEA-URCHINS of the SOUTH AUSTRALIAN MUSEUM.

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Text figs. 108-142.

The collections dealt with in this report are the property of the South Australian Museum, Adelaide, and were sent to me for study by Mr. Edgar R. Waite, the late Director of that institution, to whom I extend my heartiest thanks. My thanks are also due, for opinions and helpful suggestions, to my colleagues, Mr. A. H. Clark (of the United States National Museum), Dr. W. K. Fisher (of Leland Stanford Junior University), and Dr. Th. Mortensen (of Copenhagen). All holotypes are in the Museum collection.

This is the sixth considerable collection from Australia which has been entrusted to me for study, apart from my own collection from Torres Strait, and it is in many particulars the most notable. As the holothurians of the South Australian Museum were studied and reported on by Joshua and Creed (1), no holothurians were sent to me, but in spite of that, far more specimens are in this collection than in all the other five combined. The number of forms represented is much larger than even in the notable "Endeavour" collection, and although the new species are not quite so numerous as in that great series, they are equally interesting as a contribution to our knowledge of the echinoderm fauna of Australia. Moreover, while the "Endeavour" collection contained one form so extraordinary as to require a new genus for its reception, the present collection contains two such, one a brittle-star, the other a sea-urchin; fortunately both are represented by a large series of specimens.

The South Australian Museum collection contains 2,937 specimens, representing 140 species and five varieties. Of these, forty-one representatives of twenty species are non-Australian, and, as most are common European or American forms, it seemed best not to include them in their normal systematic position, but to devote the report wholly to the Australian fauna. Nevertheless, in the introductory paragraph to each class I have listed these species in order to make the report on the collection complete.

(1) *Trans. Roy. Soc. S. Aust.*, xxxix, 1915, pp. 16-24, pls. ii-iv.

There are then 2,896 specimens, representing 120 species and five varieties of Australian echinoderms. It is unfortunate that a number of specimens have no labels showing the locality whence they came, and a larger number have labels with the somewhat indefinite information, "Spencer and St. Vincent Gulfs." As a result there are cases where the origin of the specimen is very uncertain, but in many of the most important species the locality labels are sufficiently detailed to meet our requirements.

The bulk of the collection comprises material collected by Sir Joseph Verco in the course of his extensive dredging and searching for molluscs. As a result of his indefatigable efforts noteworthy series of many rare and remarkable echinoderms are preserved in the Museum. At least seventy-five of the 125 species and varieties in the collection were taken by him, and material of twenty-one new forms, including the two aforementioned new genera, was accumulated by him.

Nine of the 125 forms are crinoids, thirty-nine are asteroids, thirty-nine are ophiurans, and thirty-eight are echini. It is noteworthy that so large a proportion are echini, for there are at least twice as many ophiurans now known as there are echini, and probably at least three times as many sea-stars. No fewer than thirty-one new species and two new varieties are here described. In addition a sea-star and a brittle-star also probably represent undescribed species; there is only a single specimen of each, in a condition which does not warrant detailed description. At least six species are here recorded from Australia for the first time, so that practically one-third of the forms in the collection are additions to the list of Australian echinoderms.

Of the 125 forms, thirty are from the coasts of northern, north-western, or north-eastern Australia, and hence belong to a tropical fauna quite unlike that of the southern coasts of the continent. No fewer than sixty-four of the remaining ninety-five forms are confined to the coasts of Australia south of latitude 33°, and as these make up the characteristic fauna of South Australia, it seems worth while to list them here:

CRINOIDS.

*Comatula brachiolata*
*Comanthus trichoptera*
*Ptilometra macranema*
*Compsometra incommoda*
*Euantedon paucicirra*

ASTEROIDS.

*Astropecten pectinatus*
„ *preissii*
„ *syntomus*
*Nectria multispina*
*Nectria ocellata*
*Pentagonaster dübeni*
*Tosia australis*
„ „ var. *astrologorum*

*Anthaster valvulatus*
*Austrofromia australis*
*Petricia vernicina*
*Asterina atyphoida*
*Patiriella calcar*
„ *gunnii*
*Nepanthia grandis*
*Echinaster glomeratus*
„ „ var. *extremus*
*Pleetaster decanus*
*Allostichaster regularis*
*Smilasterias irregularis*
*Uniophora granifera*
„ *gymnota*
„ *multispina*
„ *obesa*
„ *sinusoida*
„ *uniserialis*

OPHIURANS.

*Ophiomyxa australis*
*Astroconus australis*
*Ophiacantha brachygnatha*
*Ophiocomina australis*
*Amphiura trisacantha*
*Ophiactis tricolor*
*Ophiothrix albostriata*
„ *caespitosa*
„ *hymenacantha*
„ *lineocaerulea*
*Ophiocoma canalicultata*
„ „ var. *pulchra*
*Ophiurodon opaeum*
*Pectinura assimilis*
*Ophiarachnella ramsayi*
*Amphiophiura colleta*
*Ophiomusium anisacanthum*
„ *aporum*
„ *simplex* var. *australe*
*Ophiocrossota heteracantha*

ECHINI.

*Genocidaris incerta*
*Temnopleurus australis*
*Microcyphus annulatus*
„ *compsus*
„ *pulchellus*
„ *zigzag*
*Amblypneustes ovum* var. *pachistus*
*Holopneustes inflatus*
*Pachycentrotus australiae*
*Ammotrophus cyclius*
„ *platyterus*
*Echinocyamus platytatus*
*Fibularia plateia*

The following fifteen species are also characteristic of the southern Australian region, but occur north of lat. 33° at least on the West Coast, where some range as far north as Shark Bay, between 24° and 28°:

*Astropecten vappa*
*Luidia australiae*
*Echinaster arcystatus*
*Astroboa ernae*
*Amphiodia mesopoma*
*Ophiothrix spongicola*
*Goniocidaris geranioides* var. *tubaria*
*Amblypneustes formosus*
„ *ovum*
„ „ var. *grandis*
„ *pallidus*
*Holopneustes porosissimus*
*Helioeidaris erythrogramma*
*Peronella peronii*
*Protenaster australis*

No doubt some (perhaps many) of the species on the first list will be found to belong to the second, when the fauna of Western Australia is better known, but the two lists together give an excellent indication of the echinoderm fauna of the coast of South Australia. Other species are known from the last-named, but we are not yet in position to attempt a complete summary of the echinoderm fauna of that interesting region.

We are still very ignorant regarding the fauna of the coast of the Northern Territory, the number of species actually known from Port Essington and Port Darwin being insignificant. The material in the present collection is of little assistance, as it rarely has definite locality labels, and in not a few cases it merely is assumed that the specimens came from the northern coast. As an interesting contrast to the lists already given of South Australian species, it may be well, however, to list the twenty-five species which are probably from that region:

*Tetiocrinus monarthrus*
*Comanthus parvicirra*
*Lamprometra protecta*
*Oligometra carpenteri*
*Archaster typicus*
*Antheuea flavescens*
„ *tuberculosa*
*Asterina coronata fasciicularis*
„ *crassispina*
*Nepanthia brevis*
*Astrochalcis tuberculosus*
*Ophiothrix longipeda*
„ *martensi australis*
*Ophiarachnella gorgonia*
„ *infernalis*
*Ophiolepis superbus*
*Ophioplocus imbricatus*
*Prionocidaris bispinosa*
*Stomopneustes variolaris*
*Salmacis virgulata* var. *alexandri*
*Tripneustes gratilla*
*Parasalenia pöhlii*
*Echinometra mathaei*
*Heterocentrotus mammillatus*
*Peronella lesueuri*

The complete difference between the faunas of the two coasts which formerly formed part of South Australia, viz., that of the Northern Territory and that of the present State, is well emphasized by the fact that although there are twenty-one genera in the above list, and forty-nine genera in the lists given of southern Australian species, there are only half a dozen genera which occur on both lists, and these are, for the most part, large and ill-defined, as, for instance, *Asterina*, *Comanthus*, *Ophiarachnella*, and *Ophiothrix*.

It is hoped that the publication of this report will serve as a stimulus to more intensive collecting of echinoderms on both the coasts referred to, and that a study of this interesting list will lead to the solution of some of its many problems connected with the marine fauna. Such study can be pursued to greater advantage by local investigators (who can collect and observe the living animals), than by one who is handling preserved material in a museum on the other side of the globe.

# CRINOIDEA

There are 149 crinoids in the collection, representing nine species, of which two are new to science. Nearly half the specimens are the common *Comanthus* of the southern Australian coast, and more than half of the remainder are the common *Ptilometra* of the same region. Three of the nine species are from the coast of the Northern Territory, and hence belong to quite a distinct fauna from that of the other six. Each new species represents a genus new to the fauna of Australia.

## ORDER ARTICULATA

### FAMILY PENTACRINITIDAE.

#### TELIOCRINUS A. H. Clark.

#### TELIOCRINUS MONARTHRUS (2) sp. nov.

Portion of stem present, 65 mm. long, only 3·5 mm. in diameter; there are only four or five developed internodes, each with from nine to thirteen segments, which are of very unequal thickness (*i.e.*, height). Cirri over 50 mm. long, each with sixty or more segments, of which the fourth to eighth are longer than broad, all except the basal ten–twelve with a projecting tooth which is very conspicuous on the distal half of the cirrus.

Calyx 6 mm. to 8 mm. in diameter, but just above the II Br series the diameter is nearly 20 mm. Arms 27, 100 mm. to 120 mm. long, unequal in size; II Br series, 4 (3+4); III Br series, 1 only; IV Br series, present once, also 1 only; elements of division series and brachials little everted; basal brachials slightly everted and with an overlapping point on each pinnule-bearing brachial, this point being on the same side of the arm as the pinnule; on opposite side is a much less conspicuous point; these points gradually become less evident and disappear distally; first syzygy between two and three and first brachial bears a pinnule. Colour in alcohol, nearly white.

Holotype: Reg. No. E. 391.

A single specimen in alcohol, with no locality label, is all the material available of this attractive species. It is obviously nearly related to *T. liliaceus* (A.H.C.), from the eastern side of the Bay of Bengal, 419 to 463 fms., but differs from that species in having fewer internodals, much more spiny cirri, and only a single segment in the III Br series. This last feature would seem to be very characteristic, provided, of course, that further material shows it to

(2) *μόναρθρον=having one joint*, in reference to the composition of the III Br. series.

be reasonably constant. Probably the present specimen was taken off the coast of the Northern Territory. It would be quite surprising and very interesting if it proves to have been taken off the coast of South Australia proper.

Fig. 108. *Teliocrinus monarthrus;* side view of holotype (nat. size).

## FAMILY COMASTERIDAE.

### COMATULA Lamarck.

### COMATULA BRACHIOLATA.

Lamarck, Anim. s. Vert., ii, 1816, p. 535.

This characteristically South Australian species is represented by eleven specimens, of which one is without a locality label, while the others are from

either Spencer or St. Vincent Gulf. The specimen without locality is dry, and has the flat centrodorsal, 5 mm. across, with a single marginal series of fourteen stout cirri; the best of these cirri have thirty segments, and the distal half is bright rose colour, which fades out basally into very pale brown; the arms were evidently over 50 mm. long in life, and are 3 mm. wide near base. The specimens from the gulfs are in alcohol, and are not very diverse in size or appearance; no one of them has the terminal portion of the cirri rose colour, but in some individuals there is a pink tinge; the largest specimen has the centrodorsal 6 mm. across and the arms fully 90 mm. long; all the specimens have ten arms, but the cirri show considerable diversity, ranging in number from thirteen to twenty-one, and in number of segments from thirty to forty-one.

## COMANTHUS A. H. Clark.

### COMANTHUS PARVICIRRA.

*Alecto parvicirra* J. Müller, Arch. f. Naturg., vii, 1841, p. 145.
*Comanthus parvicirra* A. H. Clark, Smithson. Misc. Coll., lii, 1908, p. 203.

There are two small, broken specimens of *Comanthus* from the "northern coast of Australia" which I am referring to this species because of the small number of arms (twenty-three to twenty-seven) and the presence of twelve to fifteen cirri, each with about fourteen segments. The arms are about 125 mm. to 140 mm. long, and are noticeably slender. The general appearance of the specimens is more like that of *C. annulatum* than it is like that of *C. parvicirra*, but if the two species are really distinct on the bases of number of arms and of cirri, then these must be regarded as representing the older species.

### COMANTHUS TRICHOPTERA.

*Comatula trichoptera* J. Müller, Monatsb. k. preuss. Akad., 1846, p. 148.
*Comanthus trichoptera* A. H. Clark, Mem. Aus. Mus., iv, 1911, p. 755.

This is another of the species characteristic of southern Australia, and is represented by sixty-nine specimens from Encounter Bay, Spencer Gulf, Tumby Bay, St. Vincent Gulf, and one or more unknown localities. The largest specimen has twenty-one arms, exceeding 100 mm. each, but most of the specimens are very much smaller than this; they have twelve to twenty arms, and measure 35 mm. to 85 mm. across. There are commonly twenty to thirty cirri with fourteen to seventeen segments, but in the largest specimen there are forty-two cirri with seventeen to twenty-one segments.

## FAMILY MARIAMETRIDAE.

### LAMPROMETRA A. H. Clark.

### LAMPROMETRA PROTECTA.

*Antedon protectus* Lütken, In P. H. Carpenter, Trans. Linn. Soc. Zool. (2), ii. 1879, p. 19.

*Lamprometra protectus* A. H. Clark, Proc. Biol. Soc. Wash., xxvi, 1913, p. 144.

There are seven specimens from the "northern coast of Australia," uniformly dark brown, lightest on the centrodorsal and nearly black at the tips of the pinnules and on the disk; when dry the colour is much lighter, almost pale fawn-colour dorsally. The smaller specimens have the arms about 60 mm. long, while the larger ones have them more than 90 mm. There are thirty-five to forty cirri, with about twenty-five segments. $P_2$ is very long, especially on the outer sides of the arms, with as many as thirty-five segments in some cases. There are about forty arms in the smaller specimens, but in the large ones there are forty-seven and forty-eight.

## FAMILY COLOBOMETRIDAE.

### OLIGOMETRA A. H. Clark.

### OLIGOMETRA CARPENTERI.

*Antedon carpenteri* Bell, Zool. "Alert," 1884, p. 157.

*Oligometra carpenteri* A. H. Clark, Proc. Biol. Soc. Wash., xxi, 1908, p. 126.

There is a single specimen of this well-marked species "from cable, off Northern Territory, November, 1890." It has the calyx about 4 mm. in diameter, and the arms were 30 mm. to 40 mm. long; there are fifteen cirri with sixteen or seventeen segments. The dorsal side of the animal, including the pinnules and cirri, is very light fawn-colour, while the oral surface, including the inner side of the pinnules, is dark brown.

## FAMILY THALASSOMETRIDAE.

### PTILOMETRA A. H. Clark.

### PTILOMETRA MACRONEMA.

*Comatula macronema* J. Müller, Monatsb. k. preuss. Akad., 1846, p. 179.

*Ptilometra macronema* A. H. Clark, Smiths. Misc. Coll., l, 1907, p. 358.

This, the commonest Australian crinoid, is represented by forty-seven specimens from Encounter Bay, St. Vincent Gulf, Spencer Gulf, off Althorpe Island

(Vereo coll., 1892), and at least one unknown locality. The largest specimens have twenty-five to thirty-one arms, about 70 mm. to 80 mm. long, and more than sixty cirri, which may be 57 mm. long, and have eighty-seven segments. There are seven very small specimens, with ten arms, eighteen to twenty cirri, each nearly or quite as long as arms (20 mm. ±), with forty or more segments. Comparison of these specimens with the description and figures of *Himerometra pædophora* H. L. Clark confirm my scepticism as to that species being the young of Ptilometra, as maintained by Mr. A. H. Clark. The differences in the centrodorsal, the cirri, and the pinnules seem to me too great and too important to be ignored. But I grant that none of the Ptilometras in the present collection are small enough to enable one to reach a positive conclusion. More light is still needed on the problem.

## FAMILY ANTEDONIDAE

### COMPSOMETRA A. H. Clark.

### COMPSOMETRA INCOMMODA.

*Antedon incommoda* Bell, Ann. Mag. Nat. Hist. (6), ii, 1888, p. 404.
*Compsometra incommoda* A. H. Clark, Mem. Aust. Mus., iv, 1911, p. 792.

There are two small, dry specimens of this little species from an unknown locality. In one the arms are about 25 mm. long; the other is yet smaller. There are twenty-eight and twenty cirri, each with about ten segments.

### EUANTEDON A. H. Clark.

### EUANTEDON PAUCICIRRA (3) sp. nov.

Centrodorsal low, hemispherical, about 2.5 mm. in diameter, slightly convex; cirrus sockets closely crowded, arranged roughly in two or three irregularly horizontal series. Cirri XXV, seventeen to twenty-six (usually about twenty), 10 mm. in length, more or less; three basal segments broader than long, but remainder longer than broad; sixth to tenth nearly, or quite, twice as long as the thickness at middle; in profile, the segments except basally and distally are concave on the dorsal side, much less so ventrally; distal margin of longer segments oblique, the ventral side being considerably longer than dorsal; cirri compressed distally: terminal claw, short, curved, very sharp; opposing spine, small, but sharp and conspicuous.

Radials nearly or quite concealed by centrodorsal; I $Br_1$ oblong, about four times as wide as long, lateral edges straight, parallel, a trifle everted; I $Br_2$,

(3) *Pauci*=few+*cirrus*, in reference to the relatively small number of cirri.

low, twice as broad as long, pentagonal with lateral margins, about half as long as those of I $Br_1$; distal angle a right angle; anterior sides little if at all concave. Arms ten, about 40 mm. long; first brachial wedge-shaped, twice as long externally as internally, just in contact internally with its fellow of the adjoining

Fig. 109. *Euantedon paucicirra;* side view of holotype (x 2).

arm; second brachial, wedge-shaped, larger than first; third and fourth brachials united by syzygy, the pair about twice as long as wide; next four brachials somewhat wedge-shaped, two or three times as broad as long; succeeding brachials very obliquely wedge-shaped, about as long as broad, distally becoming elongate and little wedge-shaped. Syzygies occur between brachials three and four, nine and ten, fourteen and fifteen, and then at intervals of three muscular articulations.

$P_1$, 5 mm. to 7 mm. long, rather stiff, tapering, much stouter than succeeding pinnules; it has ten to twelve segments, of which the basal is twice as broad as long; the second, longer than broad; following, twice, and distally thrice, as long as broad; third and following segments with distal edge on outer side, somewhat prominent. $P_2$, 3·5 mm. long, with seven segments, slightly more elongate than those of $P_1$, with somewhat more prominent ends. $P_3$ slightly shorter than $P_2$, somewhat more slender, less stiffened, and with a gonad. Colour (dry) nearly white.

Holotype: Reg. No. E. 399.

There are two specimens of this delicate little comatulid, labelled St. Vincent Gulf. It is very closely allied to *E. tahitiensis,* but is distinguished by the fewer, smaller cirri. The genus was hitherto known only from Tahiti, the Moluccas, and perhaps the coast of China, so that its occurrence in St. Vincent Gulf is indeed notable.

# ASTEROIDEA

There are 766 sea-stars in the collection, representing forty-four species and two varieties, but twenty-one specimens, representing the following seven well-known species, are non-Australian in origin:

*Psilaster andromeda* (M. & T.)
*Pentagonaster pulchellum* Gray
*Hippasteria phrygiana* (Parelius)
*Patiriella regularis* (Verrill)
*Echinaster eridanella* M. & T.
*Crossaster papposus* (Fabr.)
*Asterias rubens* L.

No further reference will be made to these species.

Of the remaining thirty-nine forms, ten species and one variety are described as new, while one more species, a Coronaster, is probably new, but the only specimen in the collection is too young to permit a satisfactory description. One other species, *Anthenea flavescens,* is now recorded from Australia for the first time.

Of the thirty-nine forms, thirty-three are from the southern coasts of South Australia, while six are from the waters of the Northern Territory; one of these six, an Asterina, is new.

Nearly half of the 745 specimens represent the common Australian forms of Tosia and Patiriella, while more than a hundred of the remainder are the common *Coscinasterias calamaria* and *Allostichaster polyplax.*

A new species of *Nectria* has justified giving an artificial key to the species now known of that characteristic Australian genus. Even more desirable is a key to the species of Uniophora, another very characteristic genus of the southern Australian and Tasmanian coasts, of which forty-eight specimens, representing apparently half a dozen forms, are in the present collection. Whatever may be the actual status of these forms, as determined by future research, the key will be useful in making clear the grounds upon which I have recognized them.

## ORDER PHANEROZONIA

### FAMILY ASTROPECTINIDAE.

#### ASTROPECTEN Gray.

#### ASTROPECTEN PECTINATUS.

Sladen, Jour. Linn. Soc. Zool, xvii, 1883, p. 251.

There is a very small *Astropecten* (R = 13 mm.) from Petrel Bay, St. Francis Island, South Australia, which I think must be referred to this species.

There is also a larger specimen (R = 40 mm.) taken by Dr. Verco in either St. Vincent or Spencer Gulf, and three little ones (R = 10 mm. to 15 mm.) from St. Vincent Gulf, which are also best treated as young *A. pectinatus*.

## ASTROPECTEN PREISSII.

Müller & Troschel, Arch. f. Naturg., ix, 1843, p. 119.

This would seem to be the common *Astropecten* of southern Australia, as there are sixteen specimens in the present collection, from Spencer Gulf, St. Vincent Gulf, north coast of Kangaroo Island (April, 1888), and one or more unknown localities. More than half the specimens were collected by Dr. Verco. The smallest specimen has R = 12 mm., the largest R = 102 mm. The change in proportions with increasing size is quite notable; in a specimen with R = 15, r = 7, so that R is little more than 2 r but in the largest specimen, r = 17 mm., so that R = 6 r. Most of the specimens are nearly white, dull yellowish, or pale brown, but one lot of four specimens from an unknown locality is rich red-brown; these specimens look as though they had retained their colour in life more or less perfectly, but there are no notes to indicate what the colour in life may have been.

## ASTROPECTEN SYNTOMUS (4) sp. nov.

R = 39 mm., r = 12 mm., br = 14 mm.; R = more than 3 r but less than 3 br; form very markedly stellate; rays tapering steadily to attenuate tips, but no superomarginals meet in the midradial line proximal to the terminal plate, which is large, about twice as long as wide, apparently bare except at middle of proximal end. Superomarginals twenty-four, covered with granules, of which median are largest, marginal becoming filiform; on plates six to nine several of these granules are larger than the rest, and on plates ten to eighteen the central one of these becomes a small, thick, blunt spine, placed on outer, distal corner of plate. Paxillae small, about fifteen longitudinal series at base of arm, with ten to twenty thick, blunt spinelets, of which marginal tend to be slender and central tend to be granules. Madreporic body large, bare, less than its own width from marginal plates.

Interradial areas each with about thirty plates, forming four series on each side; the first extends to the sixteenth or seventeenth adambulacral plate, the second to the seventh, the third to the fifth; these plates carry tufts of spinelets, the central one larger than others, much longer, flattened, somewhat spatula-like, wanting on first series. Lower marginal plates with numerous, filiform spinelets around margin, and fifteen to eighteen more or less flattened spines

(4) σύντομος=*cut short, brief*, in reference to the relatively short arms.

on surface; these vary much in size, but four form a series obliquely across upper end of plate, with uppermost adoral, and lowest, most distal; two uppermost about equal in size, the two lower a trifle shorter and three about equal to four; these spines are about 3 mm. long, scarcely $\frac{1}{2}$ mm. wide, somewhat flattened, acuminate; they form, of course, a conspicuous marginal fringe; above,

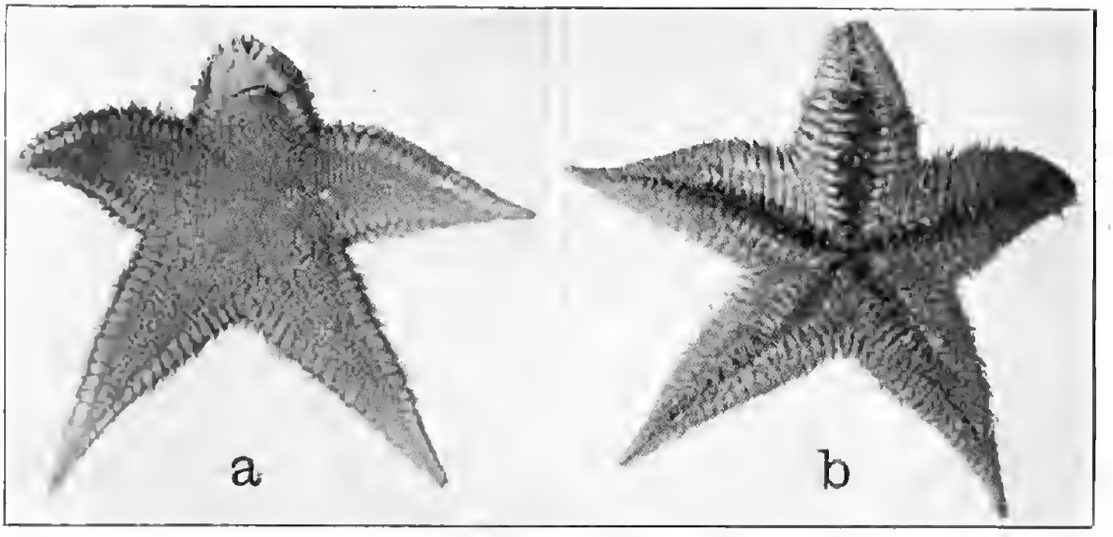


Fig. 110. *Astropecten syntomus*; a, aboral view; b, oral view of holotype (nat. size).

increasing the density of the fringe, are four similar but smaller spines. Adambulacral armature made up of a marginal or furrow spine, and several spines in irregular pairs on surface of plate. Oral plates well covered with spines, eighteen to twenty on surface of each half; they are blunt, distal ones small, proximal two or three, especially innermost, rather large; there are seven marginal spines on each side, of which the innermost is much the largest. Colour (dry), pale yellowish-brown.

Holotype: Reg. No. E. 409.

There is only a single specimen of this well-marked species, and it has no locality label. It is obviously allied to the Tasmanian species, *A. schayeri* Döderlein, but is easily distinguished by the character of the armature on the marginal plates, both upper and lower; the arms are also more attenuate than in *A. schayeri*, with more superomarginals; there are many more actinolaterals and there are fewer surface spines on the adambulacral plates.

## ASTROPECTEN VAPPA.

Müller & Troschel, Arch. f. Naturg., ix, 1843, p. 119.

There is a small sea-star, with R = 14 mm., from an unknown locality, which I think may well be considered a young example of this species. Döderlein,

in his admirable monograph on the genus *Astropecten* (1917), has cleared up the confusion between this species and *A. pectinatus* Sladen. Both species occur on the coast of south-eastern Australia, and in both my "Thetis" and "Endeavour" reports I failed to distinguish them, as no adequate description or figure of *A. vappa* was then extant.

## FAMILY LUIDIIDAE.

### LUIDIA Forbes.

### LUIDIA AUSTRALIAE.

Döderlein, Siboga Rep., lxxxviii, Mon. 46 b, 1920, p. 266.

There are seven specimens, each with seven arms, all adult. All but one are typical of this southern species, recently separated from the long-known *L. maculata* M. & T. of Asiatic coasts, and this one shows the distinctive species character clearly. Döderlein *(l.c.)* suggests that *L. australiae* may be regarded as only a local form of *L. maculata*, and gives in his key (p. 235) two points of difference, one in the form of the arm, the other in the character of the paxillae near the tip of each arm. Examination of all the adult specimens available to me (eleven from Australia and three from Hong Kong) has satisfied me that the Australian species is well established, but I do not see any difference in the form of the arm between it and *L. maculata*. In the character of the paxillae on the distal part of the arm, however, *L. australiae* stands out well, the median paxillae being larger and of markedly unequal size, while the series of lateral paxillae are much less regular and conspicuous than in *L. maculata*. It is worth noting further that all recorded Australian specimens have seven arms, while most specimens of *L. maculata* seem to have eight or nine, though seven-armed specimens are not rare.

Of the specimens in the South Australian collection, five are without locality labels, and one is from St. Vincent Gulf. These specimens have R = 150 mm. to 210 mm., and show little diversity, except that some are much browner than others. The seventh specimen is from between Trowbridge Lighthouse and Kangaroo Island, and was collected by Dr. Vereo. All of the arms have been broken at some time, and four have regenerated from 5 mm. to 18 mm. of new arm. On these regenerated tips the colour is the variegated dull yellow and blackish usually shown, but elsewhere the whole dorsal surface is uniformly brown; moreover, the paxillae in this individual are noticeably smaller than usual, but the distal part of the arm shows the characteristic inequality of size.

## FAMILY ARCHASTERIDAE.

### ARCHASTER Müller & Troschel.

### ARCHASTER TYPICUS.

Müller & Troschel, Monatsb. k. preuss. Akad. Wiss, 1840, p. 104.

A single specimen, with R = 65 mm., nearly white, dry, but in fine condition, is from Port Essington, Northern Territory.

## FAMILY GONIASTERIDAE.

### NECTRIA Gray.

### NECTRIA MULTISPINA (5) sp. nov.

R = 80 mm. to 85 mm.; r = 30 mm. to 32 mm.; br (at very base of arm) = 35 mm. R = 2·7 r ±. Disk covered with large tabulate plates, having four to six sides, though the angles may be rounded; these plates are largest on the radial areas of disk, where they may be as much as 7 mm. across; upper surface of arms covered with smaller, lower, nearly circular plates of diverse sizes, the larger separated from each other by the smaller; all plates more or less convex (largest with rather flat tabulum), and covered by swollen, hemispherical or polygonal granules of unequal size; on the smaller plates one or more of the granules are very much larger than those around the margin, while on the larger plates there is a series of small marginal granules, and the rest of the plate is covered by six to twenty large, closely appressed, polygonal, convex granules, of which one to six at centre are much the largest, and may be 1·5 mm. to 2 mm. across. Marginal plates distinct, about thirty-two or thirty-three in each series, on each side of ray; proximally the plates are higher than long, and covered with fifty or more coarse granules, subequal in size, but distally they become squarish, and some of the central granules become enlarged, polygonal, appressed.

Actinal intermediate areas moderate, with more than one hundred plates, but half of these are in the series adjoining the adambulacrals, extending out about two-thirds the length of the arm; remainder arranged in three or four series, of which the first extends out to the seventh inferomarginal or further, and the last is confined to the vicinity of the first two marginals; all these plates are covered with coarse granules (few and very coarse on distal plates); on

(5) *Multispinus*=having many spines, in reference to the adambulacral armature.

several of the proximal plates of the first series a conspicuous, very stout, erect pedicellaria is present, with two to four, usually three, wide, blunt or truncate jaws; pedicellariae were not detected elsewhere.

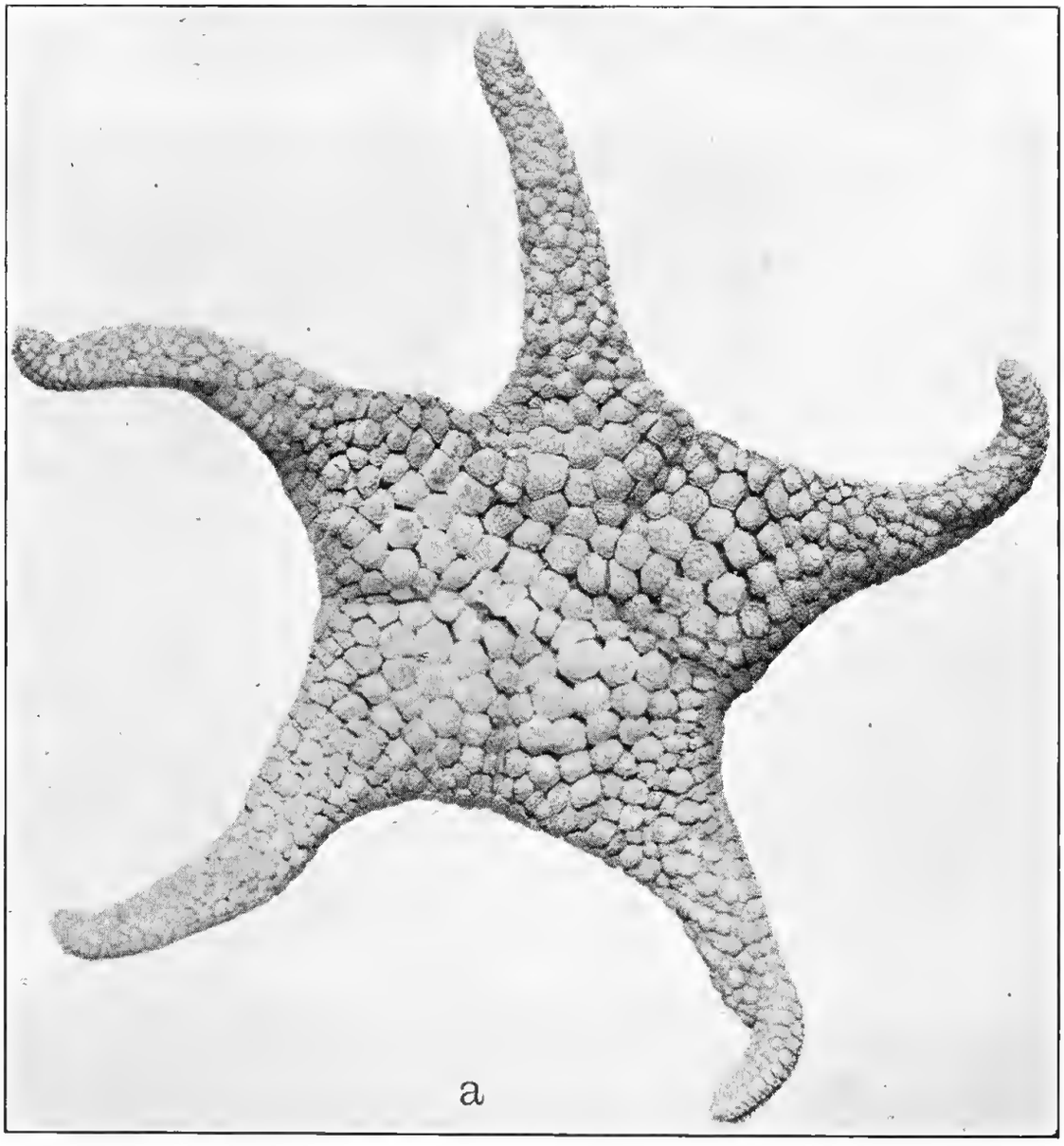


Fig. 111a. *Nectria multispina*, aboral view of holotype (⅘ nat. size).

Adambulacral plates with six furrow spines, becoming five and even only four distally, and three short, stout, prismatic spines on the surface of each plate; middle furrow spines longest, 2·5 mm. or more; adoral spine decidedly shortest, flattest, and widest; all furrow spines more or less prismatic, with angles and tips rounded. Oral plates with nine marginals, innermost very stout;

on surface of each plate four low, stout, prismatic but round-tipped spines; on distal part of each plate are several similar but much smaller spines. Colour (dry), brown.

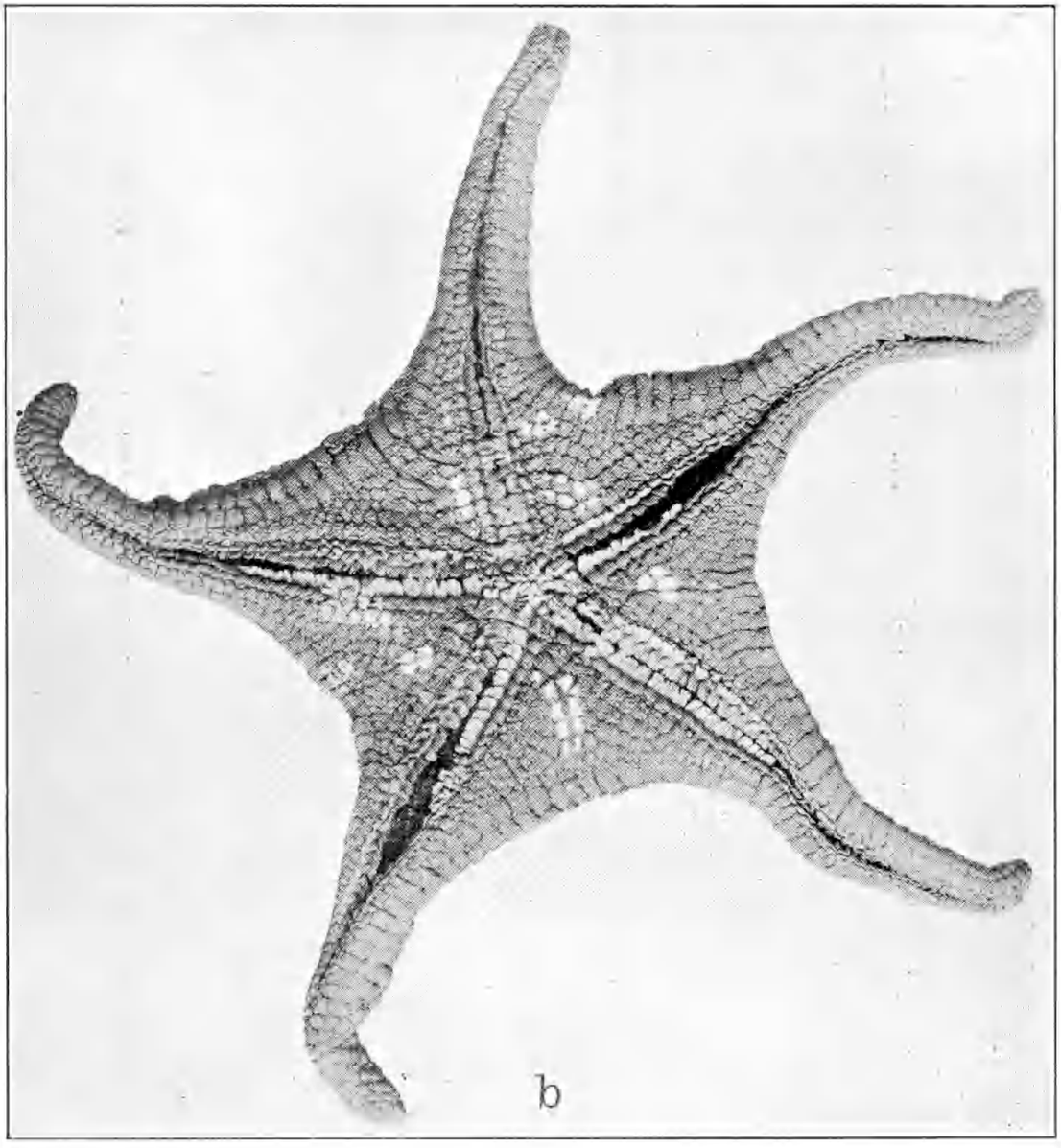


Fig. 111b. *Neelria multispina*, oral view of holotype (⅘ nat. size).

Holotype: Reg. No. E. 413.

There are three paratypes, which show no important differences, except such as might be expected from their smaller size, as R = 57 mm. to 65 mm. The adambulacral armature shows only five furrow spines proximally, four distally, while on the surface of the plate there are three or more smaller spines

as well as the three large ones; proximally the three smaller spines stand in a series back of the three larger, and both are parallel to the furrow series, but distally the arrangement is less and less regular. In the smallest specimen the oral plates have their spines very regularly arranged (it is less easy to make out in the larger specimens); there are eight spines on each proximal margin, innermost largest; back of these is a series of four (on one side, five on the other) short, very stout spines; running along distal margin of plate is a series of similar but much smaller spines, five on one side, four on other; these series converge, of course, so that the distalmost spines of the two series are side by side; within the area enclosed by these regular series are two to four, usually three, small, blunt spines, like the distal marginals.

There is no locality label with these specimens, but as they are said to have been taken by "Dr. Verco, February, 1891," it seems almost certain that they were collected in either Spencer or St. Vincent Gulf. They differ strikingly from the other species of *Nectria* in the character of the dorsal tabulae, in the adambulacral armature and oral plates, and in the pedicellariae.

## NECTRIA OCELLATA.

Perrier, Arch. Zool. Exp., v, 1876, p. 4.

There are twenty-eight specimens of this well-known species, from Spencer and St. Vincent Gulfs, from Granite Island, Victor Harbour, and from unknown localities. They have been of great value in enabling me to understand the specific limits in the genus. They range in size from young ones with R only 6·5 mm., to large adults, in which R = 90 mm. and more. In all, regardless of size, the dorsal tabulae are more or less nearly circular, only very rarely sufficiently near together to become somewhat polygonal through mutual pressure, and are covered by more or less hemispherical granules, which are rarely so crowded as to be in contact; in a few cases granules at or near the centre of the tabula are conspicuously larger than those nearer the margin, but they are never so crowded, so sharply polygonal, or so large as in *N. multispina*. In the smallest specimen there are three adambulacral furrow spines on the most proximal plates, and there are no more in the largest specimen; this seems to be a very constant specific character in *N. ocellata*.

In order that the specific characters of the five forms of *Nectria* now known may be made clear, I venture to offer the following key. I cannot agree with Fisher that my *Mediaster monocanthus* is better placed in *Nectria*, and hence I do not include it.

## KEY TO THE SPECIES OF *NECTRIA*.

a. Furrow-spines of adambulacral armature, two to four, usually three; no conspicuous pedicellariae on actinal plates near mouth.
  b. Disk large, R = 2·5 to 3 r or br; rays wide at base tapering rapidly to tip; actinal plates with rounded granules, not usually so crowded but that the series of plates are easily seen.
    c. Dorsal tabulae with rounded or polygonal granules, often crowded, the marginal ones thick, not flattened.
      d. Pedicellariae few or wanting; when present on adambulacral plates, they have three or four wide, blunt (or truncate) jaws .. .. .. *ocellata*
      dd. Pedicellariae numerous; those on adambulacral plates with four to six pointed, spine-like jaws .. .. *pedicelligera*
    cc. Dorsal tabulae with flat "granules" of very irregular shape and unequal size, not at all crowded; the marginal ones conspicuously flat and scale-like, forming a regular, radiating, marginal fringe .. *ocellifera*
  bb. Disk smaller, R = 3·5 to 4 r or br; rays narrower at base, less tapering; actinal surface covered with crowded, coarse, prismatic granules, obscuring the series of actinal, intermediate plates .. .. .. .. .. *macrobrachia*
aa. Furrow-spines, five to six; conspicuous pedicellariae present on first series of actinal intermediate plates proximally; dorsal tabulae covered by large, closely appressed granules, of which one to six at centre are much the largest, 1 mm. to 2 mm. across .. .. *multispina*

In reference to section a of the above key, I may say that it is not clear from Mortensen's (6) description and figures whether such pedicellariae are present in the New Zealand species, *pedicelligera*, or not, but the other pedicellariae of that species are surely distinctive. In addition to the peculiarities of the pedicellariae, the adambulacral armature of the New Zealand form indicates that Mortensen is right in regarding it as a separate species, but the dorsal plates and their covering granules, and the size and number of the marginal plates are not essentially different from some Australian specimens of the same size. Attention must be called to the striking difference in covering of the dorsal tabulae as described by Mortensen, and shown in his figure 9b (p. 293), and as revealed in his photograph (pl. 13, fig. 5). Different specimens from Australia

(6) Mortensen, Vid. Med., lxxix, 1925, pp. 291-293.

show a similar diversity, but how the unique holotype of the New Zealand species can have such tabulae as shown in fig. 9b without their showing thus in the photograph, is quite incomprehensible.

## PENTAGONASTER Gray.

### PENTAGONASTER DÜBENI.

Gray, Proc. Zool. Soc., 1847, p. 79.

This typically Australian sea-star is represented by fourteen specimens, of which twelve have no locality labels and two are from Spencer and St. Vincent Gulfs, Verco collection. They range in size from R = 9·5 mm. to R = 67 mm., and in colour from white to deep purple-brown; one specimen is nearly vermilion-red, as in life. In the smallest specimen r = 6·5 mm., hence R = less than 1·5 r; when R = 15 mm., r = 8, or R = a trifle less than 2 r; when R = 32, r = 14, or R = 2·25 r; when R = 65 mm. to 67 mm., r = 25 to 28, or R = 2·32 to 2·7 r; the typical proportion in adult specimens seems to be R = 2·5 r. Pedicellariae are abundant, especially in the large specimens. In the smallest specimen there are four superomarginal plates on each side of each ray, the interradial largest, the distalmost smallest, but in specimens with R = 15 mm. and 25 mm. respectively, although there are still only four plates on each side, the distalmost is as large as the interradial, or even larger. In specimens with R = 30 mm. to 35 mm. there are five or six plates on each side of a ray, but the distal are smaller than the interradial, and if six are present the sixth is much the smallest. A specimen with R = 40 mm. has five plates on each side of every ray, with the penultimate the largest, while a second specimen of the same size has six plates on each side of a ray, except in one case where there are but five; in this specimen the interradial plates are the largest. A specimen with R = 50 mm. has six plates on six sides, and seven plates on four, with interradial plates largest. A specimen with R = 54 has seven plates on each side of a ray, with interradials largest. When R exceeds 60 mm. there are likely to be eight plates on a side, with the interradials decidedly the largest.

The inferomarginals in the youngest specimens correspond in number and position with those of the upper series, but after R = 30 mm. there are generally (but not always) one or two more plates in the lower series; the additional plate (or plates) is (or are) at the tip of the arm, the distal superomarginal or two overlying two, three, or even four inferomarginals.

The adambulacral armature changes little during growth; there are two (rarely three) furrow spines, and two or three in the series immediately back of the margin, while in the largest specimens there are three (rarely two) furrow spines and three or two spines in the following series.

Pedicellariae are not usually common on the oral side; there are none in the smallest specimen, and only one in one of the big ones; the specimen with the most has sixty-eight, or an average of thirteen or fourteen to each interradial area. In small specimens there are many pedicellariae dorsally, but there are none on the eleven primary plates; in large specimens practically every dorsal plate has from one to six pedicellariae, a total of more than six hundred.

The dorsal plates are often, if not usually, quite flat, but they may be somewhat convex; particularly the primary plates and the proximal carinals tend to be somewhat convexly elevated. In one specimen the dorsal plates are all more or less convex, while the first carinals and the large interradials are so markedly elevated that it would be but a step to low tubercles. Possibly specimens occur with such tubercles (as in *P. stibarus*), but none are recorded, so far as I know.

Mortensen (7) suggests that my *Pentagonaster stibarus* from Western Australia is identical with *Astrogonium crassimanum* Möbius. While this is possible, there are three differences at least that must be reconciled before *P. stibarus* is abandoned. In the Western Australian species the primary plates, particularly the central one, tend to carry tubercles, or at least to be quite convex; nothing of this sort shows in Möbius's species. In *P. stibarus* there are many more plates both dorsally and ventrally, particularly on the rays and in the actinal interradial areas. Finally, in *P. stibarus*, even in the young specimens, there are three adambulacral spines in both the furrow series and the one back of it, while in *A. crassimanus* there are but two.

## TOSIA Gray.

### TOSIA AUSTRALIS.

Gray, Ann. Mag. Nat. Hist. (1), vi, 1840, p. 281.

The large number of *Tosias* in the collection has been a source of difficulty, because of the difference in appearance of the two extremes of the series, and the completeness of the intergradation between those extremes. On the one hand are those which have the marginal plates only slightly convex and the terminal pair on each ray not at all swollen. On the other hand are those with strongly convex marginals, and having the terminal pair conspicuously swollen. There does not seem to be any other difference worthy of note between the two extremes. The first extreme is evidently typical *T. australis*, while the other is surely *Astrogonium astrologorum* Müller & Troschel. After a careful examination of the whole series, it seems to me worth while to retain the name *astrologum* for

(7) Mortensen, Vid. Med., lxxix, 1925, p. 285.

those individuals with conspicuously convex marginal plates, but I am confident that they are merely a variety, and by no means a valid species.

I am referring to typical *T. australis* 107 specimens, ranging in size from 8 mm. across (R = 4 mm. ±) to 72 mm. (R = 38 mm.). There is a reasonable amount of constancy in the number of superomarginals, as eighty-two specimens, including all the very small ones, have just thirty, six on each side of the body, and thirteen others have six on each of four sides. There are three specimens with eight on each side, another has eight on each of four sides, and another has eight on each of three sides. There are seven specimens with only five plates on one side, but there is no case of five plates on more than one side, and twenty-nine supero-marginals is the smallest number noted in any specimen, save one extreme aberrant described later. The specimens with only five plates on one side are all less than half grown. The three specimens with eight plates on each side are perfectly symmetrical; one is 26 mm. across, and has only eight or nine inferomarginals on each side; another is 39 mm. across, and has twelve inferomarginals on each side; the third is 63 mm. across, and has fourteen inferomarginals on each side, and the additional marginal plates in both series are distal, small, and symmetrically placed, obviously a normal addition with the increased size.

While there are several cases of half-plates, or still smaller fragments inserted in the marginal series, there are only four aberrants that call for special comment. In one there are six plates on each of four sides, while on the fifth side there are nine plates, with a half-plate and a still smaller fragment just below the antepenultimate plate; this specimen also has a nearly circular madreporite about 6 mm. across, double the normal size. Another specimen has one side badly deformed, with ten and a half supero- and fifteen and a half inferomarginals. Then there is an individual which is hexagonal in outline, with six superomarginals on each of three sides, five on a fourth side, four on a fifth, and only three and a half plates on the sixth side; seen from below, there are only five ambulacral furrows at the mouth, but 4 mm. out, one of these forks, giving rise thus to the hexagonal form. Finally there is an extraordinary specimen, about 50 mm. across, in which the marginal plates are greatly reduced in number. In interradius 1 (Loven's system) there are two superomarginals, three inferomarginals, and three marginals which may belong to either series, but only two inferomarginals lie below superomarginals; in 2 there is one superomarginal with an inferomarginal below it, one distal marginal that from its size and form evidently belongs in the upper series, three large plates that may belong in either series, and three, or perhaps four, small distal plates, of which only one is an inferomarginal; in 3 there are only two large marginal

plates, of which one is a distal superomarginal, the other doubtful, but there are three or four plates which are probably small marginals, and two of these belong to the lower series; in 4 there is one superomarginal, three subjacent inferomarginals, and five large marginals that may be either series; in 5, there are two superomarginals with four subjacent inferomarginals, three plates of uncertain position, and two or three small distal plates, of which one is probably an inferomarginal. In this specimen, then, there are not more than forty-five marginal plates, instead of the ninety that it should have.

Orienting the specimen, according to the madreporite, calling the ray opposite that plate anterior, or orienting according to the Loven system for echini, calling the ray to the left of the madreporite anterior, we do not find that there is any evident correlation between variations in the marginal plates and the anteroposterior axis; there are eight variations in one area, nine in a second, eleven in each of two others, and fourteen in the fifth. The fewest are in interradius one of Loven, the most in interradius three.

In the smallest specimen the distal marginals of each ray are the smallest, and the terminal plate is relatively large; there are six inferomarginals on each side, and each one corresponds exactly to the superomarginal above it. With growth, however, the distal superomarginal becomes the biggest, and this is indicated in a specimen only 11 mm. across, but the inferomarginal series has added another plate at each end, so we now have forty inferomarginals to thirty in the upper series. In a typical half-grown specimen, 36 mm. across, there are fifty inferomarginals, the distal three on each side of each ray underlying the large terminal superomarginal; the four median plates of the two series corresponding to each other in position exactly as they did in the youngest specimens. In typical full-grown specimens there are sixty inferomarginals, four distal ones underlying the distal superomarginal, and in those cases where there are fourteen inferomarginals on a side, five distal ones are overlain by the very large distal superomarginal. All these facts go to show that growth is provided for in the case of the superomarginals by increasing the size of the plates, especially the distalmost, while in the case of the inferomarginals, although the median ones make some increase of size, so as to maintain their relation with the plates above them, growth is chiefly provided for by additional plates distally.

Obviously *Tosia australis* is a common sea-star on the South Australian coast, and the following localities are represented in the present collection: St. Vincent Gulf, Spencer Gulf, Kangaroo Island, Port Lincoln, off Althorpe Island, Wallaroo.

### TOSIA AUSTRALIS var. ASTROLOROGUM.

*Astrogonium astrologorum*, Müller & Troschel, Sys. Ast., 1842, p. 54.

I am labelling with this varietal name thirty specimens which are recognizable by their swollen distal superomarginal plates and their correspondingly less pentagonal form. This is best illustrated by comparison of two specimens in which R = 30 mm. In the typical *T. australis* r = 24 mm., and the distal superomarginals are hardly 6 mm. long and less than 4 mm. high; in *T. astrologorum* r = 20 mm., and the distal superomarginals are 8 mm. long and over 4 mm. high. Of course these two individuals look very unlike, but there are all degrees of intergradation, so I cannot believe they are essentially different. It is doubtful whether the use of even a varietal name is justifiable, for it is certain that specimens of *T. astrologorum* occur in the same lots with typical *T. australis*, but the question must be settled at the shore and not in the museum.

Of the thirty specimens called *T. astrologorum*, the smallest is 13 mm. across, and has thirty supero- and forty inferomarginal plates; the largest is 58 mm. across, and has thirty-two supero- and fifty-seven inferomarginals. Only nineteen of the thirty have thirty superomarginals; four have thirty-one, four have thirty-two, and three have thirty-seven; those with thirty-seven have eight on each of two sides, and seven on the others. Not a specimen shows only five superomarginals on one side. In several specimens the median superomarginals (*i.e.*, those not terminals) are so elevated as to appear as though they bore a blunt tubercle.

The localities represented are Spencer and St. Vincent Gulfs only, though one lot has the label, "Port Willunga, St. Vincent Gulf."

## ANTHENEA Gray.

### ANTHENEA FLAVESCENS.

*Hosia flavescens* Gray, Ann. Mag. Nat. Hist., (1), vi, 1840, p. 278.
*Anthenea flavescens* Perrier, Arch. Zool. Exp., v., 1876, p. 92.

A single *Anthenea*, bearing the label "North Australia," seems to be the adult of this little-known species. It resembles Döderlein's var. *nuda* (8) in the deficiency in dorsal pedicellariae, but I believe that the number and arrangement of the dorsal pedicellariae are subject to great individual diversity, and are also influenced by age, so I doubt the validity of *nuda* as a constant variety. The present specimen has R = 59 mm. and r = 27 mm., and hence is much larger than any specimen available to Döderlein, yet the number of marginal plates is practically the same, thirteen or fourteen in the upper series and fifteen

(8) Döderlein, Jahrb. Nassau. Ver. Naturk., lxviii, 1915, p. 42.

or sixteen in the lower. On only three or four of the superomarginals is there a pedicellaria, but each one carries a conspicuous tubercle or low capitate spine, and the distal ones have two or even three such tubercles, though they are smaller than those on the proximal plates. Each inferomarginal, except the distalmost one or two in each series, carries a large pedicellaria, besides fifteen to twenty coarse granules and three or four times as many very small ones; many of the plates carry a second smaller pedicellaria, and rarely there is a third; the distalmost plates have only three to ten coarse granules and practically none of the very small ones. The dorsal plates are not easily made out, except on the distal half of each ray. Nearly all of the carinal plates carry small tubercles, but very rarely is there more than one to a plate, and on many plates, especially on the ray opposite the madreporite, even one is wanting. Similar but smaller tubercles, or more properly granules, replace pedicellariae on a large proportion of the adradial and other dorsolateral plates. The actinolateral plates each carry two to seven coarse granules and a large pedicellaria; here and there the pedicellaria is wanting. The armature of a typical adambulacral plate consists of a furrow series of five spines, the middle three subequal, the other two much smaller, and three very stout, blunt spines on the oral surface of the plate, two adjoining the furrow margin, and one behind them; this third spine is often wanting; of the marginal pair the distal one is usually the larger, and near the tips of the rays is the only one present. On some of the adambulacral plates near the mouth a pedicellaria is present on the adoral side. It is evident that the adambulacral armature in the present specimen is much more like that given by Döderlein for typical *A. flavescens* than it is like what he found in his variety *nuda*.

It seems to me fair to conclude that the present specimen is an adult, though not neeessarily a full-grown, example of *A. flavescens* (Gray), and that Döderlein's variety *nuda* is within the limits of the normal variation of the species.

## ANTHENEA TUBERCULOSA.

Gray, Proc. Zool. Soc., xv, 1847, p. 77.

This paper of Gray's was also printed verbatim in the Ann. Mag. Nat. Hist., xx, 1847, p. 198 (not vol. x as given by Döderlein, 1915, *op. cit.*). The Royal Society Catalogue gives precedence to the P.Z.S. paper; in fact, in this particular instance no reference is made to the publication in the Annals.

There are four specimens of this common North Australian species, but only one has a locality label, and that one is merely from "North Australia." Although they range in size from R = 50 mm. to R = 90 mm., they show very little diversity, but agree well with Döderlein's (1915, *op. cit.*) description and figures.

## ANTHASTER Döderlein.

### ANTHASTER VALVULATUS.

*Oreaster valvulatus* Müller & Troschel, Arch. Naturg., ix, 1843, p. 115.
*Anthaster valvulatus* Döderlein, Jahrb. Nassau. Ver. Naturk., lxviii, 1915, p. 30; pl. iii.

This remarkable sea-star has been known hitherto only from the holotype, which is in Berlin, and was collected by Preiss in "South-west Australia." It has R = 107 mm., and has been admirably redescribed and figured by Döderlein. The presence of thirteen specimens in the collection before me is therefore of great interest, and some notes upon them will be of interest. While they agree in the main with Döderlein's description and figures, they show some differences in the dorsal and marginal tubercles and in the adambulacral armature.

The smallest specimen, labelled "*Goniodiscus seriatus* M. & T., Kangaroo Island," has R = 42 mm. and r = 21 mm. A second specimen with it from the same locality is only a trifle larger. The pedicellariae show that they are not *Goniodiscus seriatus,* but are young *Anthasters.* In the smaller individual the only dorsal tubercles are five, placed one at the base of each ray on the most proximal plate of the carinal series; in the larger specimen there are some additional tubercles on other carinal plates, two to four on each ray, but only three or four of these are big enough to be at all noticeable. There are twelve superomarginal plates on each side of each ray, and only the four or five distalmost have tubercles large enough to mention; nearly every plate has a pedicellaria, and often there are two. The inferomarginals are essentially the same as the upper series in number, size, and general appearance, but their pedicellariae are somewhat larger though scarcely equal to those occurring on nearly all of the actinolateral plates. In the adambulacral armature there are eight spines in the furrow series, though the first and last are very small; there are three short, wide, blunt spines in the second series, and two or three much smaller ones in the outermost row; there is usually a pedicellaria on the adoral margin of each plate.

The largest specimen has R = 112, r = 52, and breadth of arm at middle about 40 mm. There are fifteen superomarginals in each series, and the same number in the lower series. In appearance and tuberculation they are like those of the smallest specimens. Dorsal tubercles rather numerous, occurring on most of the carinal plates, most of the disk plates, and on many other plates at the base of the rays, but they are rarely present on the distal part of the rays. The adambulacral armature is similar to that found in the smaller specimens, but there are often nine spines in the furrow series. All the spines

are stouter, particularly those on the oral surface of the plate, where there are often three series, though the outermost may consist of only a single spine.

The specimens of intermediate size are very similar to the others. The chief diversity is in the number and conspicuousness of the dorsal tubercles, for there is very little diversity in the armature of either the marginal or adambulacral plates. One specimen with R = 80 mm. has only nine or ten dorsal tubercles, while another with R = 77 mm. has about 180. In all cases the five primary tubercles are the largest, but they are seldom more than 3 mm. high, and their basal diameter is about equal to the height. They are thus much smaller than in Müller & Troschel's type.

All of the specimens are "museum colour," dull yellowish or brown of some shade, but there are two plaster casts in the collection which were evidently painted to show the colour in life. These are both a deep violet-red above, but one is pure white (unpainted) on the oral surface, while the other is coloured a fine salmon-red along the ambulacra, with a slight violet tinge to the red of the interradial areas. It is possible that there is considerable diversity in the colouring of the oral side, but it is not at all likely that it is ever pure white.

The species is apparently common on the South Australian coast, but the only definite localities indicated besides Kangaroo Island are St. Vincent Gulf, Althorpe Island (Dr. J. C. Verco), Glenelg (Mr. A. T. Beaumont), and South Australian coast (W. J. Conroy).

## FAMILY OPHIDIASTERIDAE.

### AUSTROFROMIA H. L. Clark.

### AUSTROFROMIA POLYPORA.

*Fromia polypora* H. L. Clark, *Endeavour* Res., iv, 1916, p. 51; pl. xiv, figs. 1 and 2.

*Austrofromia polypora* H. L. Clark, Dept. Mar. Biol. Carn. Inst., X, 1921, p. 48.

There are three specimens of this imperfectly known species, but unfortunately not one of them has a locality label. The smallest has R = 65 mm., and the colour (in alcohol) is reddish-buff, suggesting that the species is more or less red in life. The other specimens are dry, and much larger than any previously known. In one R = 95 mm., r = 19 mm., and br = 19 mm., hence R = 5 r or br. The other has R = 112 mm., r = 22 mm., and br = 27 mm., hence R = 5 r but only 4 br. In the smaller specimen the rays are very little flattened, but are quite terete, while in the larger there is a little more indication of flattening, but it is not at all marked. In each specimen the actinal interbrachial areas are so large that there are five, and possibly six, series of

actinolateral plates, but owing to the close granulation of all plates it is not easy to make out the various series, and even the marginal plates are much obscured. The colour of these dry specimens is bright brown, with a yellowish tinge; in the larger one the disk and bases of the rays on the upper surface are almost black, and this dark colour extends orally on three rays almost to the ambulaeral furrow, but it does not approach very near to the mouth; in the smaller specimen this dark area is only faintly indicated on the upper part of the bases of the rays, the greater part of the disk being quite free from it. After careful examination I am led to believe that this dark colour is not normal, but is due to some oily material, perhaps the stomach contents or a secretion from the hepatic glands, which has stained the specimens.

## FAMILY ASTEROPIDAE.

### PETRICIA Gray.

### PETRICIA VERNICINA.

*Asterias vernicina* Lamarck, Anim. s. Vert., ii, 1816, p. 554.
*Petricia vernicina* Fisher, Zool. Anz., xxxiii, 1908, p. 357.

A fine series of thirty-four specimens ranges in size from R = 30 mm. to R = 58 mm. There is considerable diversity of form, aside from the differences caused by preservation. At one extreme is a specimen with R = 50 mm., r = 25 mm., and br at $\frac{1}{2}$R = 24 mm.; at the other is a specimen with R = 55 mm., r = 25 mm., and br at $\frac{1}{2}$R = 18 mm.; most specimens are intermediate between these two extremes. Most of the alcoholic specimens are dull red-brown in colour, but a few are light yellowish-brown, or even a dirty cream-colour; dry specimens are dirty white, yellow-brown, red-brown, or very dark red-brown.

As regards the big pedicellariae characteristic of the genus, there is the greatest diversity; there should be one in each actinal interradial area, near mouth, and one at the base of each ray, on each side dorsally, fifteen in all, five oral and ten aboral. But this symmetrical condition is very rare, and is shown by only one of the thirty-four specimens. Only one other specimen has five oral pedicellariae, and fifteen specimens lack them altogether; four specimens have four, four have three, five have two, and four have a single one; thus the thirty-four specimens average only one and a half oral pedicellariae apiece. There are six specimens which have ten aboral pedicellariae, one has eleven, and one has twelve; two have nine, two have eight, three have seven, three have six, two have five, four have four, six have three, one has two, two have but one, and one specimen has none at all; thus the thirty-four specimens average only

six aboral pedicellariae each. The individual with twelve aboral pedicellariae is symmetrically six-rayed, with R = 43 mm., but it has only two oral pedicellariae. It is interesting, though probably not significant, that five individuals have no oral and only three aboral pedicellariae. It must be said, however, that twenty-eight of the thirty-four *Petricias* are in alcohol, and many of them are more or less distorted; hence, owing to the thick, fleshy skin which covers the whole animal, the aboral pedicellariae are often difficult to detect, and it is not unlikely that some have been overlooked. Their presence does not seem to be correlated in any way with size; in the smallest specimen there are two oral and seven aboral pedicellariae, while in the largest there are no oral and only four aboral; there is, however, no indication that the pedicellariae tend to decrease or disappear with age.

Unfortunately there are no locality labels with any of the specimens except the smallest, which was taken by Dr. Verco in Spencer or St. Vincent Gulf.

## ORDER SPINULOSA

### FAMILY ASTERINIDAE.

#### ASTERINA Nardo.

#### ASTERINA ATYPHOIDA.

H. L. Clark, "Endeavour" Res., iv, 1916, p. 57.

There is a fine series of thirty-nine specimens of this little-known but easily recognized species; the smallest are about 12 mm. across, while the largest are 22 mm., and thus somewhat bigger than the original specimens. One of the 22 mm. specimens has R = 11 mm. and r = 11 mm., and is thus almost circular in outline, but another has R = 11 mm. and r = 10 mm., and is distinctly pentagonal. There is little diversity in the appearance of the upper side, but some individuals have more than others of the pointed granules along the proximal margins of the plates. Orally there is very little diversity, the species characters seeming to be remarkably constant. There is no hint as to the colours in life, all of these specimens being "museum colour," ranging from nearly white to pale brown, usually yellowish, occasionally reddish.

Most of the specimens (twenty-three) are from "Spencer or St. Vincent Gulf," but eight are from "between Trowbridge Light House and Backstairs Passage," seven have no locality label, and one is from "between Backstairs Passage and the Pages, 1888."

## ASTERINA CORONATA FASCICULARIS.

Fisher, Bull. 100, U.S. Nat. Mus., iii, 1919, p. 414.

There are three dry, dull-coloured specimens of this little-known species, bearing the labels, "N. Territory" and "North Australia." Fisher *(l.c.)* lists an *Asterina* from Port Essington as of this subspecies. The present specimens have five rays each, and R ranges from 20 mm. to 30 mm. There are about fifteen to twenty-two enlarged abactinal plates on each ray, but these are conspicuous more for their elevation than for their size. There are six to eight oral (marginal) spines, usually six furrow spines (occasionally one or even two more), and four to six, usually five, pointed spinelets in a group on each actinal intermediate plate, of which one or two are distinctly larger than the others. Pedicellariae such as Fisher describes and figures for the subspecies *euerces* occur in the largest specimen, and are common in one of the smaller ones, but I do not find them in the third, which is, however, rather poorly preserved. These specimens are thus intermediate between the subspecies *euerces* and *fascicularis*, but on account of the actinal intermediate spinelets and the geographical origin I refer them to *fascicularis*. I confess to some doubt, however, as to whether the various subspecies of *coronata* will prove to be recognizable when a considerable amount of material is available for study.

## ASTERINA CRASSISPINA (9) sp. nov.

Rays five, rounded into blunt tips; R = 20 mm., r = 11 mm., br. = 12 mm. General form stellate; dorsal plates not imbricating, and with the exception of a few near base of ray, not ereseentie; covered with blunt spinelets, scarcely twice as long as thick, forming a rather uniform granular coat all over dorsal side. Papulae rather numerous; a double row along midradial line (*i.e.*, a series on each side of the row in carinal plates), and three or four rows, on each side decreasing in length outwardly, so that the outermost has only two papulae. Madreporite, small, triangular but rounded, very near centre of disk.

Oral surface with rather large interradial areas; actinal intermediate plates each with one or two, usually two, wide, blunt, flattened spines, a millimetre long or less, and almost half as wide as long. No pedicellariae. Adambulacral plates with furrow comb of four subequal spines about 1·25 mm. long and rather slender; on surface of plate are two blunt, heavy spines, like those of the actinal intermediate plates, but somewhat larger. Oral plates with six

(9) *Crassus*=heavy, thick+*spina*=a thorn, spine, in reference to the very stout spines of the oral surface.

marginal spines, innermost longest; on each oral plate is a huge suboral spine, 1·75 mm. long, ·60 mm. to ·75 mm. wide, squarely truncate, flattened. Colour (dry), dull yellowish.

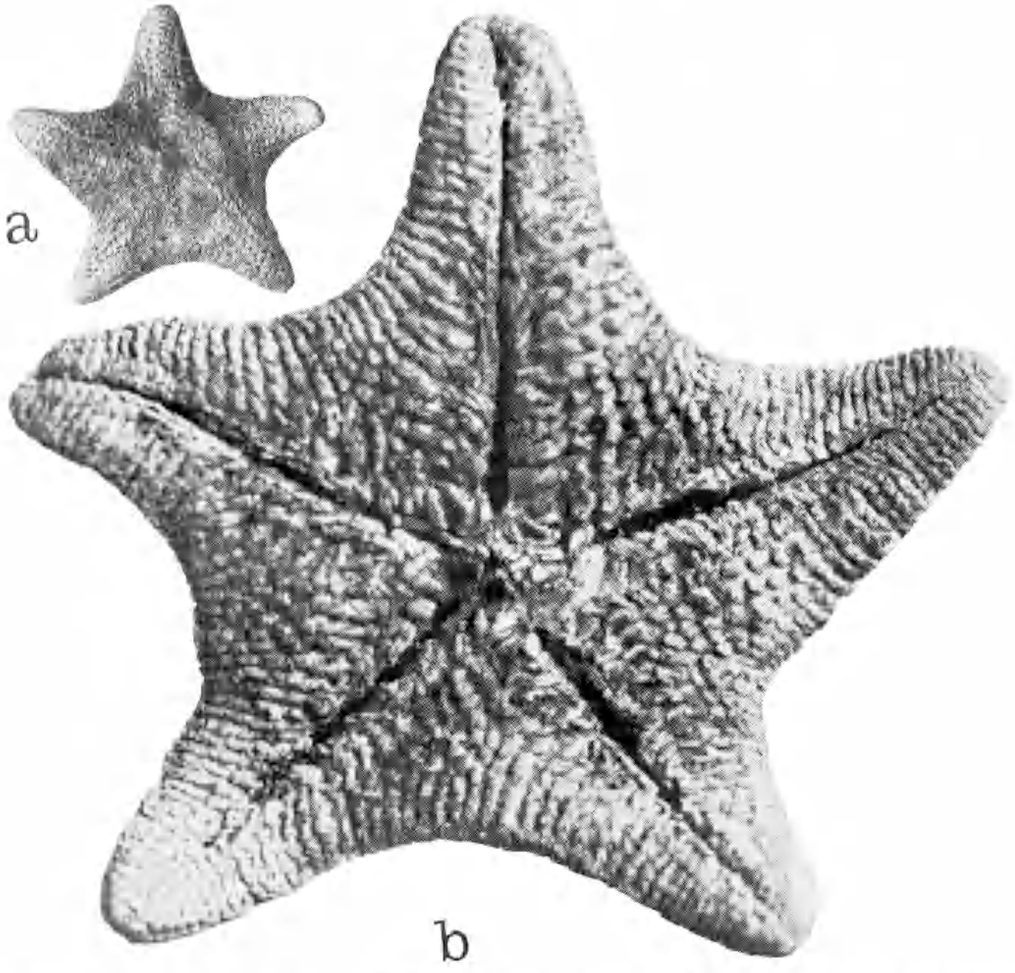


Fig. 112. *Asterina crassispina*; a, aboral view (nat. size); b, oral view of holotype (x 3).

Holotype: Reg. No. E. 425.

The unique type bears the label "N. Australia," indicating that the coast of the Northern Territory is the locality whence it came. It is in rather poor condition, but its distinctive characters are well marked.

## PATIRIELLA Verrill.

### PATIRIELLA CALCAR.

*Asterias calcar* Lamarck, Anim. s. Vert., ii, 1816, p. 557.
*Asterina calcar* Gray, Ann. Mag. Nat. Hist., vi, 1841, p. 290.
*Patiriella calcar* Verrill, Amer. Jour. Sci., xxxv, 1913, p. 484.

There is a good series of twenty-six specimens of this well-marked species, ranging from R = 16 mm. to R = 54 mm. All have eight rays. The colour ranges from nearly white to dark brown, but there is no hint of the fine colours of life. The localities represented are: New South Wales: Bondi, Zietz coll., 1906, November; South Australia: Guichen Bay, Mr. A. Zietz, 1889, March; Encounter Bay, Dr. R. H. Pulleine, 1886; St. Vincent Gulf, Dr. Verco, 1889; St. Vincent and Spencer Gulfs.

## PATIRIELLA EXIGUA.

*Asterias exigua* Lamarck, Anim. s. Vert., ii, 1816, p. 554.
*Asterina exigua* Perrier, Arch. Zool. Exp. v, 1876, p. 222 (302).
*Patiriella exigua* Verrill, Amer. Jour. Sci., xxxv, 1913, p. 484.

This well-known species is represented by twenty-five specimens from: New South Wales, Bondi, 1906, November, A. Zietz coll. (ten); South Australia, St. Vincent and Spencer Gulfs (twelve); Kangaroo Island (two); and North Australia (one). The two specimens from Kangaroo Island and one of those from Bondi have but four rays, while one from Bondi has six rays. All of the specimens are small, ranging from R = 4 mm. to R = 11 mm.; thus the largest is little more than half the size of fully-grown specimens. None show any trace of the colour possessed in life. The species is readily distinguished from *P. regularis*, and, when six-rayed, from small specimens of *P. gunnii*, by the bare, smooth area back of the oral plates in the actinal interradii; this bare area may reach half-way to the margin, and is very characteristic.

## PATIRIELLA GUNNII.

*Asterina gunnii* Gray, Ann. Mag. Nat. Hist. (1), vi, 1840, p. 289.
*Patiriella gunni* Verrill, Amer. Jour. Sci., xxxv, 1913, p. 484.

The large series of this characteristically Australian sea-star contains 163 specimens, which range in size from R = 7 mm. to R = 70 mm. An equally great diversity is shown in form, in part due to difference in the proportion of R to r, but chiefly due to difference in preservation. In rare cases r = R, and the outline is thus approximately circular; more commonly R = 1·16 r, and the outline is hexagonal; but often the rays are more prolonged, and R = 1·20 to 1·35 r; in extreme cases R = 1·5 r. Dried specimens are often very flat, the vertical diameter not exceeding ·06 of the horizontal; more commonly it is ·10 to ·20, and in some well-preserved specimens rises to ·30 or more, in extreme cases to ·40. Of the 163 specimens, 140 (85%) have six rays, and sixteen (or about 10%) have seven, while there are five with eight rays and one with only five. One specimen has an ambulacral furrow forked half-way between mouth

and tip, so that there are six and a half furrows; seen from above the specimen has seven sides, but two are shorter than the other five. Eight-rayed specimens with long rays might be confused with *P. calcar*, but the paired spines on the actinolateral plates distinguish them at once. Small specimens might be confused with *P. exigua*, especially if there were only five rays, but the absence of the large suboral spine on the mouth plates always distinguishes *P. gunnii*.

All of the present series are "museum colour," ranging from dirty-whitish to very dark brown; one or two show distinctly reddish shades. The localities represented are all in South Australian waters, but most of the specimens have no locality labels; there are specimens, however, from Port Lincoln, St. Francis Island, Althorpe Island, Kangaroo Island, and St. Vincent and Spencer Gulfs, Verco coll. One specimen is labelled "*Asterina regularis* Verrill, New Zealand"; it is, however, a typical hexamerous South Australian *P. gunnii*, and we must interpret the "New Zealand" as merely an indication of the region inhabited by *P. regularis*, with which species this specimen was wrongly identified.

## NEPANTHIA Gray.

### NEPANTHIA BREVIS.

*Asterina (Nepanthia) brevis* Perrier, Arch. Zool. Exp., v, 1876, p. 241 (321). *Nepanthia brevis* Sladen. "Challenger" Rep., xxx, 1889, p. 387.

There is a single specimen of this fine species from "North Australia." It is fully grown, R equalling 43 mm. It is "museum colour," and shows no trace of the handsome markings possessed when living.

### NEPANTHIA GRANDIS [10] sp. nov.

R = 40 mm to 45 mm., r = 23 mm to 25 mm., br = 25 mm. to 29 mm.; R = 1·75 r or 1·6 br.; form more or less markedly stellate; margins, especially in interradii, more or less extended, flattened, and apparently flexible in life. Disk and median portion of rays well arched; oral surface very flat. Rays five (of the twenty-six specimens, three are six-rayed), tapering gradually to a rounded and rather wide tip. Disk and median portion of rays covered by irregularly arranged plates of several sizes, their elevated centres roundish, elliptical, or crescentic, and densely covered with very delicate, glassy spinelets; the elevated part of the plate which carries the spinelets is nearly as high as the length of the spinelets themselves; scattered among these plates are the papulae, often single, especially along margin, but proximal to each of the larger plates on base of rays they are in pairs or groups of three, and on the disk there are from four to seven in a group; in the interradial areas and along the margins

[10] In reference to the size as compared with other members of the genus.

of the rays the plates are much smaller, the elevated portion is more or less circular, and they are arranged in regular, crowded, longitudinal series, among which there are no papulae; in small specimens there are five or six such series on each side of each ray, but in the large specimens the number rises to nine or ten, and the contrast between them and the median area of irregularly arranged plates may be very marked, although, like them, they are densely covered with fine spinelets. Terminal plate rather small and covered with spinelets. Madreporite small, near centre of disk; often overshadowed by its neighbouring plates, and not easy to see.

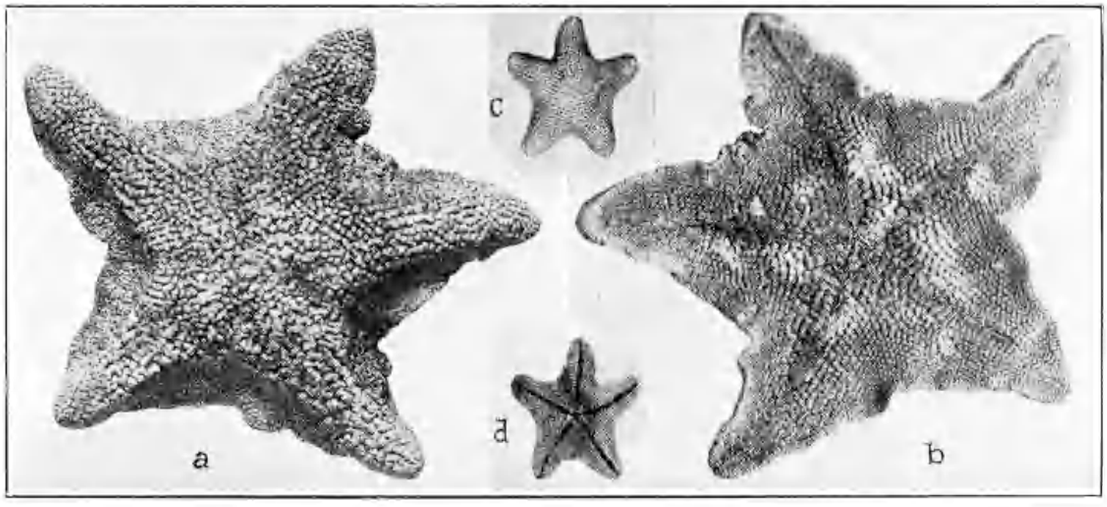


Fig. 113. *Nepanthia grandis;* a, aboral view and b, oral view of holotype; c, aboral view and d, oral view of juvenile (⅔ nat. size).

Oral surface entirely covered by rhombic plates, the outlines of which are indistinct; the centre of each plate is elevated into a circular knob, densely covered with spinelets just like those of the aboral side; the plates are largest just back of the oral plates, and become very small at the margin; they are arranged in definite transverse series, which are, of course, oblique on the interradial areas, but come to be at right angles to the ambulacral furrow on the rays. Adambulacral plates with a furrow series of six to eight blunt, relatively long and stout (actually they are slender) spines, back of which is an equal number of somewhat smaller ones, and back of them, covering the rest of the plate, are numerous slender spinelets, like those of the actinolateral plates. Oral plates very similar to the adambulacral, but the eight marginal spines are larger, especially those at tip of jaw; surface of plate well covered with spinelets. Colour ranges from nearly white to deep reddish-brown, but there is no indication of what it may have been in life.

Holotype: Reg. No. E. 430.

There are twenty-six specimens at hand of this somewhat perplexing form, which I have placed in *Nepanthia*, in spite of its relatively large interradial areas, because the skeleton, the covering of spinelets, and the adambulacral armature all seem to indicate its position in that genus. The smallest specimens have R only 7 mm. or 8 mm., and are very *Asterina*-like in appearance, but careful examination shows they are essentially like the adults. The largest specimen has R = 60 mm. and r = 25 mm., hence R = 2·4 r; there are eight to eleven furrow spines on the adambulacral plates. Of the six-rayed specimens two are very small, but one has R = 40 mm.; it is fairly, but not perfectly, symmetrical. All of the specimens are apparently from the South Australian coast, chiefly Verco collections from Spencer and St. Vincent Gulfs; one small specimen bears the label "Tumby Bay."

## FAMILY ECHINASTERIDAE.

### ECHINASTER Müller & Troschel.

### ECHINASTER ARCYSTATUS.

H. L. Clark, Rec. W. Aust. Mus., i, 1914, p. 148.

This species, hitherto known only from the holotype, taken on the Western Australian coast, is apparently not rare in South Australian waters, for there are four specimens in the present collection. Unfortunately only one has a definite locality label; this reads, "Between Backstairs Passage and the Pages. Dredged in 25 fathoms. Field Nat. Exp., April, 1888." This specimen has R = 65 mm., and is very well preserved, while two others of about the same size are in less satisfactory condition. The fourth specimen is a very large one, with R = 172 mm. and r = 22, so that R is almost equal to 8 r. In the smaller specimens, and in the original holotype, R = 6·5 r. The arms are very slender on the big individual, with br = 24 mm. at base of arm and only 16 mm. at middle, hence R = 7 br at base, and almost 11 br at middle of arm; in the smaller specimens R = 4 or 5 br at base and only 6·5 br at middle. All of the specimens are dull brown in their dried condition, but there are indications that the colour in life is deep red or red-brown.

### ECHINASTER GLOMERATUS.

H. L. Clark, "Endeavour" Res., iv, 1916, p. 62.

There are three dry specimens of this species, originally found near Kangaroo Island; two are without locality labels, while the third was taken "Between Backstairs Passage and the Pages. Dredged in 25 fathoms. Field

Naturalists' Exc., April, 1888''; it is thus from the same place, and taken at the same time as the specimen of *E. arcystatus*, referred to above. Like the latter it is in excellent condition, being admirably preserved; it has R = 100 mm., r = 20 mm., and br = 20 mm.; the heaps are very conspicuous, and the spinelets taller and sharper than in the holotype. The colour is a bright yellow-brown, not at all suggestive of a red colouration in life. The other two specimens are not in such good condition, as they are crusted over with some foreign material, having apparently dried with the evaporation of the spirits in which they were preserved; one was, in life, evidently much like the specimen from Backstairs Passage, but the arms are relatively wider at base (R = 97, but br = 25 mm.), and more tapering; the other has R = 90, br = 18 mm., and arms tapering little, but its chief peculiarity is that the ''heaps'' bear more numerous, shorter, and blunter spinelets; this specimen thus approaches the variety *extremus*, described beyond.

Besides the dry specimens there are four in alcohol, two without locality labels, and two from the Verco collections in Spencer and St. Vincent Gulfs. The two without locality are in rather poor condition, and are of such a light brownish-yellow there is little doubt that they have been bleached by the alcohol; in one, R = 80 mm., br = 19 mm., and the arms are flat and tapering, while in the other, with R = 75 mm. to 80 mm., and br = 17 mm. to 18 mm., the arms are stouter, more cylindrical, and less tapering. The Verco specimens are smaller and in better condition; one has R = 55 mm. to 60 mm., with br. = 11 mm. to 12 mm., and is bleached to a very pale brownish-yellow; the other has R = 65 mm. to 75 mm., with br = 15 mm. to 16 mm., and the colour is yellow-brown; both specimens are quite typical.

### ECHINASTER GLOMERATUS var. EXTREMUS [11] var. nov.

R = 60 mm., r = 12 mm., br = 12 mm., R = 5 r or br. Rays nearly cylindrical, tapering but little. Heaps of spinelets, numerous, very large, in seven to nine longitudinal series, with four to twenty or more short, stout, blunt spinelets or coarse granules; three to nine papulae in each area. Colour, yellow-brown.

Holotype: Reg. No. E. 432.

This specimen has no locality label, but there is no reason to doubt that it came from South Australian seas, probably from St. Vincent or Spencer Gulf. The general appearance is so striking it seems desirable to give the form a name, though it probably intergrades completely with the typical form.

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[11] In reference to the extreme development of the heaps of spinelets.

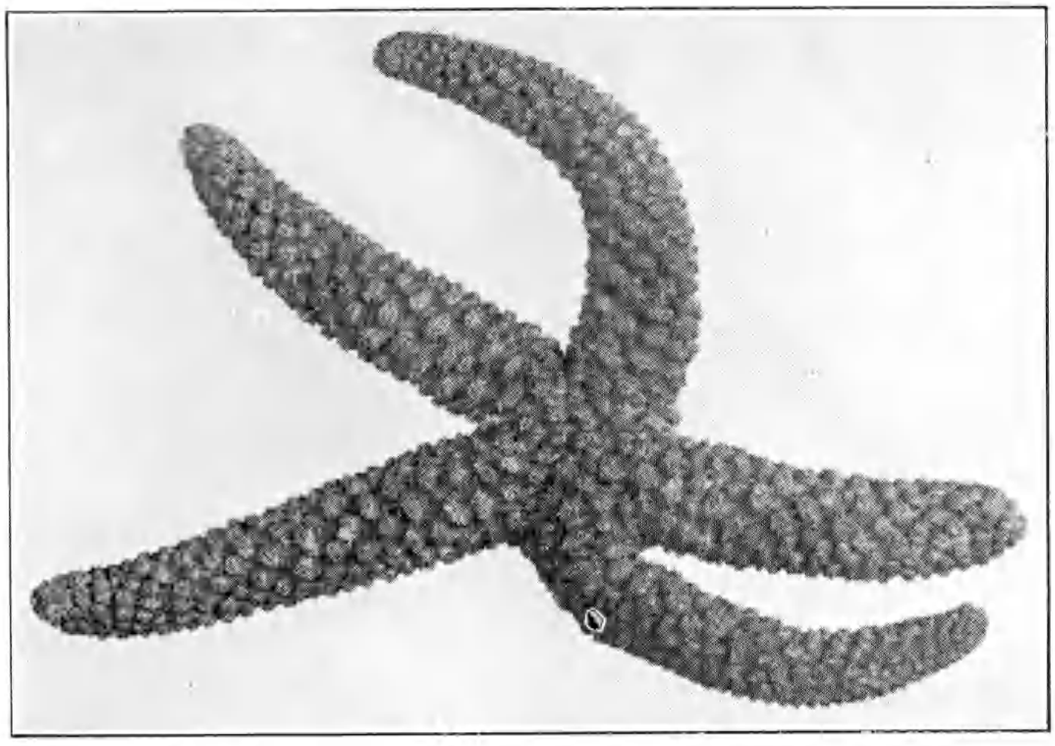

Fig. 114. *Echinaster glomeratus* var. *extremus*; aboral view of holotype (nat. size).

## PLECTASTER Sladen.

### PLECTASTER DECANUS.

*Echinaster decanus* Müller & Troschel, Arch. f. Naturg., ix, 1843, p. 114.
*Plectaster decanus* Sladen, "Challenger" Rep., xxx, 1889, p. 535.

There are seven specimens of this typically Australian sea-star, but none are in very good condition, and only two have locality labels; these two are from Spencer and St. Vincent Gulfs. The size ranges from R = 50 mm. to R = 105 mm., while the breadth of the arm ranges from ·25 to ·33 R. The only one of the individuals which offers anything of special interest is one without locality, in which R = 93 mm. on two rays, while the other rays are less than 70 mm. Careful examination shows that one of these was broken (or bitten?) off, and has not regenerated, while the other two were evidently broken long ago, and have regenerated 33 mm. to 35 mm. (or more). The remarkable feature is that on the regenerated portion of these arms the typical network of ossicles is lacking, and is replaced by isolated elevations bearing spinelets or granules, much as in *Echinaster glomeratus*, clearly indicating the stock whence *Plectaster* has sprung. There is no corresponding modification on the oral surface.

## FAMILY ASTERIIDAE.

### CORONASTER Perrier.

### CORONASTER sp.

A single small sea-star without locality has given me much difficulty, and it is only with great hesitation that I have decided to place it temporarily in *Coronaster*. Its distinctive features are so many and so striking that additional specimens will be readily recognized, and it is to be hoped that adult specimens will soon be found. It is probable that this specimen was taken by Dr. Vereo in his dredging in Spencer or St. Vincent Gulf.

The present individual is obviously young. There are six rays, 12 mm. to 19 mm. long; madreporite large, close to margin of the very small disk; abactinal skeleton a very open mesh-work, as usual in *Coronaster,* with a carinal series of cruciform plates and a superomarginal series on each side; near base of ray there may be one or more dorsolateral plates. Each plate carries a single slender spine encircled with a wreath of pedicellariae, but on the smaller spines there are few pedicellariae in each wreath. There are some very small scattered pedicellariae on the disk, but there do not seem to be any on the rays. In spite of the large naked areas left between the skeletal plates, there are very few papulae, often only one to each area, occasionally as many as four.

The inferomarginal plates adjoin the adambulacral series; there is about one to each millimetre of the ray; the single spine is slender, acute, 1 mm. to 1·3 mm. long, not very much longer than the spines of the superomarginal series. Each inferomarginal spine bears a conspicuous wreath of pedicellariae. Adambulacral plates about three times as numerous as the inferomarginals, conspicuously and consistently diplacanthid, with long, slender, but not acute spines, the outer one a trifle longer, stouter, and blunter than the inner. There are no pedicellariae in the furrow or on the adambulacral spines.

In each actinal interradial area, just back of the oral plates, is a huge major pedicellaria, strongly unguiculate, similar to those of *C. volsellatus,* but with the "wrist" shorter and stouter. No other major pedicellariae are to be found. Pedicels biserial throughout.

The small number of rays and the scarcity of major pedicellariae make me hesitate to call this little sea-star *Coronaster,* but the form of the major pedicellariae, the abactinal skeleton, the marginal and adambulacral armature, all indicate a close relationship to that genus.

## COSCINASTERIAS Verrill.

### COSCINASTERIAS CALAMARIA.

*Asterias calamaria* Gray, Ann. Mag. Nat. Hist., (1) vi, 1840, p. 179.
*Coscinasterias calamaria* Perrier, *"Travailleur et Talisman"* Ech., 1894, p. 106.

There are fifty-one specimens of this common and characteristic Australasian species, ranging in size from R = 15 mm. to R = 225 mm., and in number of rays from seven to fourteen. Apparently eleven is the normal number, as thirty have that many rays, while only four have twelve, one has thirteen, and one fourteen; in this last the rays are evidently of three, and possibly four, different age-sets. Symmetry is rare, but one specimen with eleven rays has them approximately equal and about 120 mm. long. All sorts of combination of large and small rays occur, and it is difficult to see any indication of method or sequence in the addition of new rays.

Most of the specimens have no locality label, but several very fine ones are from Kangaroo Island, and there are also good ones from Althorpe Island, collected by Dr. Vereo. A number of small ones are from Port Vincent, St. Vincent Gulf.

## ALLOSTICHASTER Verrill.

### ALLOSTICHASTER POLYPLAX.

*Asterias calamaria* Gray, Ann. Mag. Nat. Hist., (1) vi, 1840, p. 179.
*Allostichaster polyplax* Verrill, Harriman Alaska Exped.: Starfishes, 1914, p. 363.

This well-known species, common to both Australia and New Zealand, is represented by fifty-two specimens, ranging from R = 9 mm. to R = 35 mm. Of these, twenty-seven have eight rays, twenty-three have seven, and two have nine. More than half (twenty-eight) have the rays so unequal as to indicate the autotomy so characteristic of the species; usually there are two sets of rays, three or four large and three or four small, but in five cases one notes three sets, either one large, two smaller, and four quite small, or two, two, and three, or two, two, and four, or two, three, and three; in one case there are four sets, one, three, one, and two.

Most of the specimens have no locality label, but the three largest ones are from Coobowie, Yorke Peninsula, January 31, 1885, two are from Tumby Bay, two are from Guichen Bay (A. Zietz coll., March, 1889), one is from "between Trowbridge Light and Backstairs Passage," and most of the remainder are from either St. Vincent or Spencer Gulf, and are largely from the Vereo collections. There are no indications as to habitat or as to the colours in life.

## ALLOSTICHASTER REGULARIS (12) sp. nov.

R = 30 mm., r = 6 mm., br = 8·2 mm.; R = 5 r but not quite 4 br; form regularly pentamerously stellate, with equal (or subequal) rays, which are relatively high, and taper gradually to a blunt tip, where a large terminal plate is more or less concealed by granules or low spinelets; disk rather high but more or less flat, covered by a coarse network of skeletal plates, between which lie the rather large papular areas, but there are only one to three papulae in each one. Madreporite moderate, half-way between centre and margin, surrounded by a circle of a dozen or more somewhat capitate spinelets. All the dorsal plates carry such spinelets in considerable numbers and a few scattered, small pedicellariae.

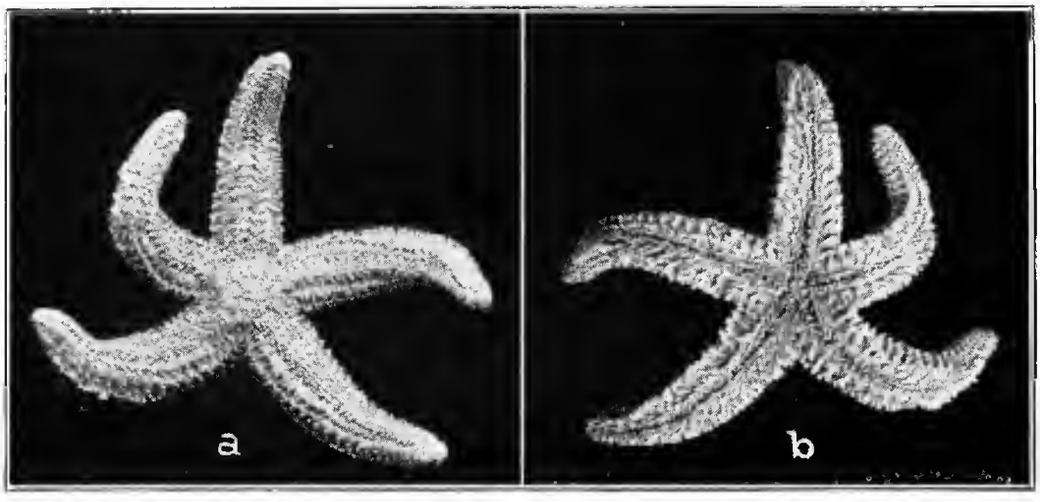


Fig. 115. *Allostichaster regularis;* a, aboral view; b, oral view of holotype (nat. size).

Superomarginals about twenty-two, higher than long, somewhat oblique, the surface more or less "beaded" at least dorsally, aborally; each plate carries about five small, somewhat capitate spinelets, of which one is rather by itself near the lower end of the plate, the others are on the adoral part of the plate, dorsally, and form an irregular oblique line; there are also eight to twelve pedicellariae on each plate. Carinal plates correspond in number with the superomarginals, and lie opposite their distal ends; each plate is wider than long, more or less triangular, at least on proximal half of ray, with an adoral angle; distally the lateral angles reach the superomarginals, but on the basal part of ray there is a single series of dorsolateral plates of rather considerable size; all the dorsal plates carry the small capitale spinelets and minute

(12) In reference to the constancy in number and appearance of rays as contrasted with *polyplax.*

pedicellariae; on the basal carinals are about ten spinelets and rather fewer pedicellariae, but distally there are only six or seven spinelets and four or five pedicellariae; each dorsolateral plate carries two to six spinelets and about half a dozen pedicellariae. Papular areas moderate with one to three papulae, usually only one.

Inferomarginals, corresponding in number and position with the superomarginals, form a very distinct angular margin to the ray, the oral surface being quite flat; each inferomarginal carries, except at very base of arm and close to tip, four spines, dorsal to which are half a dozen pedicellariae; these spines are flattened and widened at the end, the largest about a millimetre long and not quite half so wide at tip; on the basal half of the arm one of the spines is distinctly by itself on the oral surface of the plate, on its aboral margin, while the other three form an oblique comb, of which the adoral member is the most dorsal; distally as the plates become smaller the oral spine comes to lie in line with the others as the most distal and most oral member of the comb; occasionally it is quite wanting, especially on the distalmost plates; at the very base of the arm the adoral member of the comb is usually wanting. Actinolateral plates wanting, as are oral papulae, and pedicellariae are few and insignificant. Adambulacral plates regularly diplacanthid; the two spines are subequal, moderately stout, only a little flattened, but slightly widened at tip, scarcely a millimetre long. Oral plates with four spines each, of which the innermost are smallest and most wide-apart, so that the mouth angles appear to be actually widest at the tip and narrowest at the distal end; the two distal spines agree with adambulacral spines in size and form. Colour (in alcohol or dry), light yellow-brown ("museum colour").

Holotype: Reg. No. E. 437.

There are sixteen specimens of this species, of which the holotype is the largest, while one with R = 9 mm. is the smallest. In the little specimens the rays are relatively shorter and much stouter, there are no dorsolateral plates, fewer spinelets and pedicellariae, and only two or three marginal spines on the inferomarginal plates. In two specimens there are but four normal rays and one small one, but even in these cases it does not look as though autotomy occurs in this species (at any rate it must be infrequent), a very striking character which makes it easy to distinguish *A. regularis* from *A. polyplax*. In other respects the two species are much alike, but *A. polyplax* has smaller and more numerous dorsal spinelets, scarcely more than granules, and the papular areas are smaller and the dorsolateral plates more numerous.

All of the specimens of *A. regularis* at hand were taken in Spencer and St. Vincent Gulfs, but there are no exact locality labels.

## SMILASTERIAS Sladen.

### SMILASTERIAS IRREGULARIS (13) sp. nov.

Rays five, but two are broken off and one is missing; no two are even approximately equal; they measure 16 mm., 37 mm., 40 mm., and 49 mm.; r = 5 mm. and br = 6 mm. for the large arms, but only about 3 mm. for the small one; R = 9 to 10 r and about 8 br. Rays high at base, higher than wide, tapering slowly to a rather wide, blunt, slightly flattened tip. Dorsal surface of disk and rays covered with a closely reticulated skeleton, the longitudinal rows of which are not conspicuous basally, but distally the carinal series is fairly distinct; apparently there are two, and possibly three, rows of dorsolaterals on the basal part of the ray. All the plates carry a few widely-spaced, low, blunt (but not


Fig. 116. *Smilasterias irregularis;* a, aboral view; b, oral view of holotype (nat. size).

at all capitate) spinelets and more numerous, but scattered, pedicellariae. Papular areas rather large, with two to six papulae in each.

Superomarginal plates, in the largest ray, about thirty, much wider (or rather higher) than long, clearly on the sides of the rays; each carries two or three small, blunt spines, well spaced, in an irregular vertical series, and a number of scattered small pedicellariae. Inferomarginal plates correspond in number and position with the superomarginals, but they are low, decidedly longer than high, and form a distinct, angular margin to ray; each one carries two flat, square-cut spines, side by side, or placed slightly obliquely; near base of ray these spines are 2 mm. long and ·60 mm. to ·70 mm. wide. No actinal intermediate plates and no oral papulae.

Adambulacral plates rather numerous, seven or eight to each trio of inferomarginals on basal part of ray, diplacanthid; at base of ray the two spines are subequal, nearly 2 mm. long, moderately stout, blunt, and slightly flattened, but the outer spine tends to be the larger, and may become distinctly longer and

(13) In reference to the inequality of the rays.

stouter than the inner one distally, although, of course, both spines are much smaller there than proximally. Within the furrow are small, straight pedicellariae, one or none on inner face of each adambulaeral plate; no other aetinal pedicellariae, except one stout one in one interradial area. Oral plates each with three big, wide, flat marginal spines, and none on surface of plates; these oral marginal spines are as large as the inferomarginal spines, or nearly so. Tube-feet in four series at base of ray, but very soon passing into two normal series. Colour yellow-brown ("museum colour"), dry.

Holotype: Reg. No. E. 438.

This specimen is said to be from Spencer or St. Vincent Gulf, but there is no definite locality label, and there is no other specimen in the collection or in the Museum of Comparative Zoölogy at all like it. It seems to belong in *Smilasterias*, but is easily distinguished from the other species of that genus by the armature of the inferomarginal plates, for in them there are three or four inferomarginal spines set very obliquely on the plate, and in *S. scalprifera*, the genotype, moreover, the adambulacral plates are triplacanthid.

## UNIOPHORA Gray.

The considerable series of specimens of this genus has been the source of great perplexity to me, and I am not at all positive that the following treatment is the best possible, but it represents my carefully considered judgment on the material available. The specimens of *Uniophora* in the Museum of Comparative Zoology are few and of little service in this connection; none of them are from South Australia. While I am recognizing no fewer than six species of *Uniophora* in the present collection, and have already described ([14]) a seventh from Western Australia, I am quite prepared to believe that extensive collecting and comparative study on the South Australian coast would show that some of these supposed species are merely local forms—or worse. But it seems better to describe and figure them, and thus bring to the front the question of their validity, than to obscure the situation by placing apparently distinct forms under a single name.

## UNIOPHORA GRANIFERA.

*Asterias granifera* Lamarck, Anim. s. Vert., ii, 1816, p. 560.
*Uniophora granifera* Bell, Proc. Zool. Soc. London, 1881, p. 497.
*Uniophora globifera* Gray, Ann. Mag. Nat. Hist., vi, 1840, p. 288.

There are three specimens that I refer to this species with little hesitation. The largest, of which I am giving a figure, has R = 55 mm. and r = 15 mm. The other two are much smaller (R = 24 mm. and 29 mm.), and do not have nearly

([14]) H. L. Clark, Jour. Linn. Soc., Zool., xxxv, 1923, p. 244.

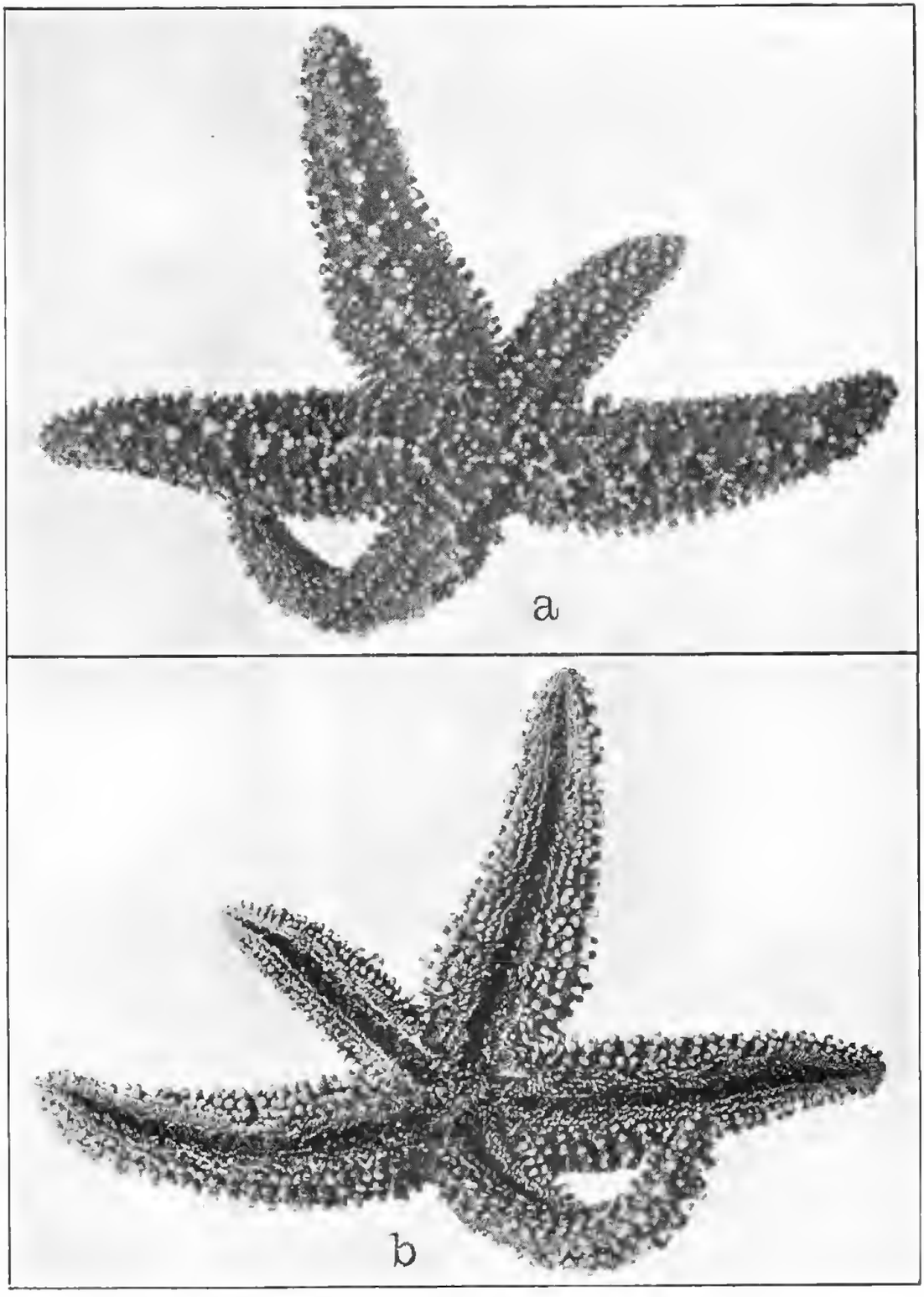


Fig. 117. *Uniophora granifera*; a, aboral view; b, oral view (nat. size).

so many of the characteristic globiferous spines on the dorsal surface. These three specimens have no locality label; they agree with each other, and differ from all the other *Uniophoras* in the collection in their deep reddish-brown colouration. I am following Fisher ([15]) in considering Gray's long-used name a synonym of Lamarck's earlier but less familiar one.

### UNIOPHORA GYMNONOTA ([16]) sp. nov.

R = 42 mm., r = 13 mm., br = 14 mm.; R = more than 3 r but just about 3 br; disk small, rays five, stout. Abactinal skeleton coarse, with large, irregular meshes; madreporite large, about half-way between margin and centre of disk. Carinal series of plates, conspicuous, closely united in a longitudinal series,

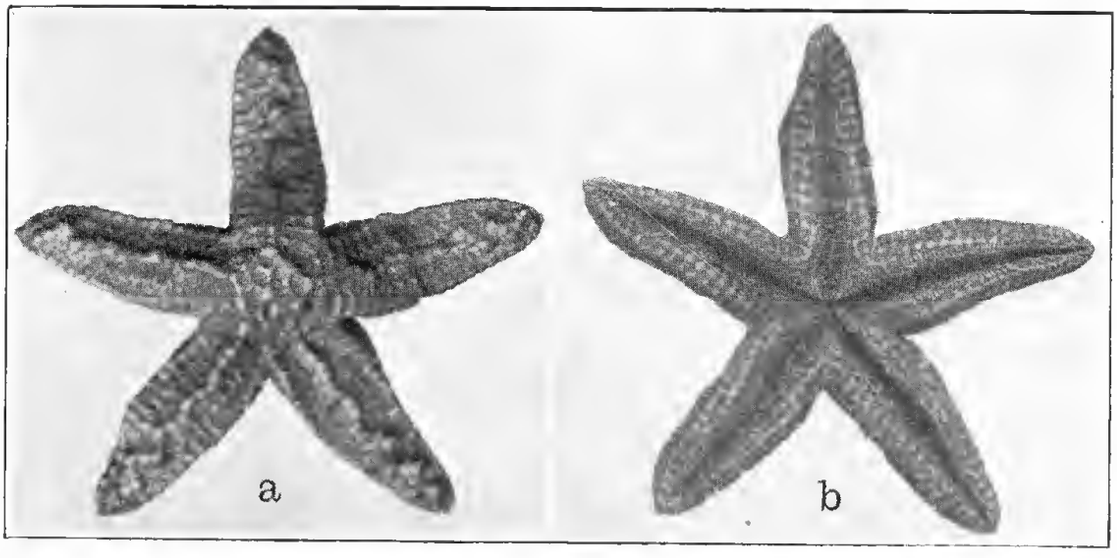


Fig. 118. *Uniophora gymnota*; a, aboral view; b, oral view of holotype (5/7 nat. size).

which distally becomes zigzag and irregular; superomarginals very similar but regular clear to tip of ray; "beading" on the superomarginals wanting proximally, well-marked only on the most distal plates; dorsolaterals in an irregular series, which is more or less clearly double proximally, and becomes obscure distally. Dorsal surface devoid of spines, except for a few small ones close to madreporite and at the tips of the rays, where two or three of the distalmost carinals carry single, low, thick spines. Small pedicellariae occur in abundance all over the dorsal surface, more especially on the large papular areas, and particularly near the tips of the rays.

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([15]) Fisher, Ann. Mag. Nat. Hist. (9), xii, 1923, p. 597.

([16]) γυμνός=naked+νῶτον=the back, in reference to the absence of spines dorsally.

Lateral portion of ray nearly vertical, the supcromarginals forming a conspicuous boundary to the rather flat dorsal surface. Inferomarginals about as large as supcromarginals, tending to be oral in position, especially proximally, entirely free from spines. Actinal plates in three series at base of ray, but the innermost series is insignificant, consisting of but few, small plates; the second series is better developed, extending about half the length of the ray; the third series is clear enough, and extends nearly to the tip of ray. There are no spines on the inferomarginals or actinal plates, except that a few of the distal actinal plates carry single short, stout ones, but these are very irregular in size and position. Adambulacral armature regularly diplacanthid; the two spines on each plate are subequal, 2 mm. to 3 mm. long, stout, blunt, and nearly cylindrical. Within the furrow are rather numerous, small pedicellariae; these are also numerous on the sides of the ray, especially distally, but are infrequent orally. Oral plates narrow, square-cut at the inner end, each with two or three, rarely four, stout, blunt spines along the margin, which when directed inward overlap and completely cover the plates. Colour, dull yellowish or yellow-brown ("museum colour"), whether in alcohol or dry.

Holotype: Reg. No. E. 440.

There are half a dozen specimens of this form in sufficiently good condition to consider as type material. They range in size from R = 19 mm. to R = 75 mm. One of the small specimens has R = 25 mm., and the rays taper regularly to a blunt tip; there is a spine at centre of disk, and several carinal plates in each series carry similar but even larger spines; orally there is only one series of actinal plates, but most of them carry a single stout spine. The other small specimens, with R = 19 mm. to 32 mm., have the rays very stout and blunt, not at all tapering, the width at middle of ray being much more than a third of R. Some of the carinal plates carry conspicuous spines, and a large number of the actinal plates carry heavy spines. In the largest specimen, and also in the smallest, there are no dorsal spines, except for one or two small ones near tips of rays, while the actinal spines, although much more numerous than in the holotype, are scattered and irregular. It is clear that the deficiency in spines is more a matter of individual diversity than it is of age, but it certainly gives the form a very distinctive appearance. Alcoholic specimens show that in life the animal is covered with a thick fleshy skin, which more or less conceals plates and spines (except the adambulacrals and orals), and that the papulae are fairly numerous but not excessively so; the pedicellariae on the papular areas are numerous, and have fleshy bases, in which they are more or less sunken.

The holotype was dredged in "Backstairs Passage, near the Pages, about 25 fathoms; April, 1888; Field Naturalists' Excursion." Of the other specimens two are from Spencer or St. Vincent Gulf, while the remainder have no locality labels at all.

In addition to these type specimens there are sixteen individuals in such poor condition as to make their identification uncertain. They are dried flat, without care to prevent distortion. They range from R = 25 mm. to R = 100 mm., and have no locality label. They were in the same lot with eight specimens of *U. obesa (q.v.)*, but are recognizable by the lack of armature on the marginal plates. One of them has two rays (R = 50 mm. to 55 mm.), much smaller than the other three (r = 83 mm. to 88 mm.), suggesting autotomy, but it is more likely the fission was artificial and accidental.

### UNIOPHORA MULTISPINA (17) sp. nov.

R = 82 mm., r = 17 mm., br = 22 mm. to 23 mm.; R = almost 5 r but hardly 4 br; disk rather large, not at all elevated; rays five, rather flat, tapering to a more or less blunt point. Skeletal plates arranged as usual in the genus, with large papular areas both on disk and rays. Madreporite conspicuous but

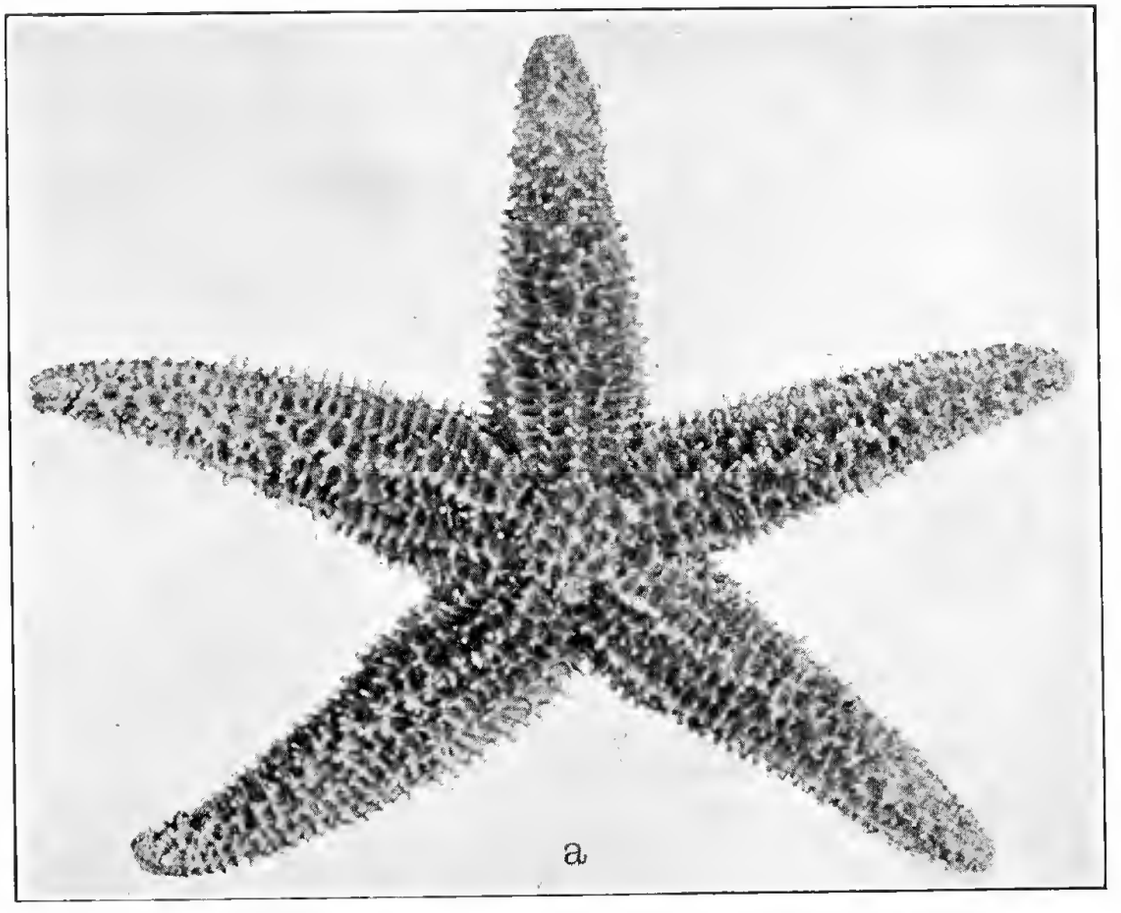



Fig. 119a. *Uniophora multispina*, aboral view of holotype (¾ nat. size).

(17) In reference to the numerous spines all over the animal.

moderate in size, half-way between centre and margin of disk, with a surrounding circle of about a dozen large, unequal spines. Carinal, dorsolateral, and superomarginal plates practically all with spines, the carinals often with two and occasionally with three or four; spines very unequal, usually cylindrical and blunt; on the carinals, often conspicuously capitate, but not to the extent

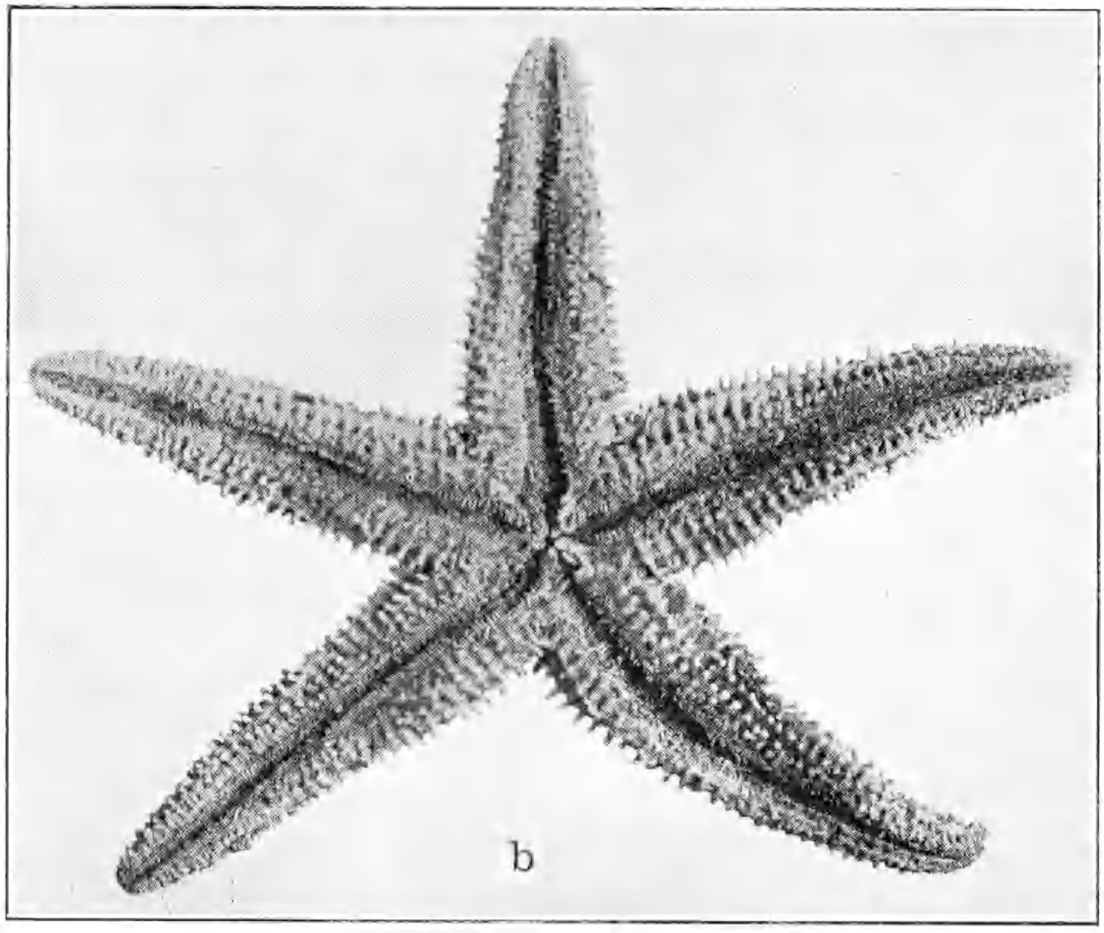



Fig. 119b. *Uniophora multispina*, oral view of holotype (¾ nat. size).

shown in *U. granifera;* superomarginal spines erect, not so capitate; "beading" on superomarginals very well-marked, even near base of ray. Many disk plates also with spines, but they are smaller than on the rays. Still smaller spines are found scattered here and there on the dorsal surface, as well as large numbers of pedicellariae.

Inferomarginal plates conspicuous, each with a prominent spine, which is short and somewhat capitate on the distal plates, but becomes longer, flattened, and widened at tip, proximally. Actinal plates in three series at base of ray, but the innermost series is short, the second reaches to about the middle of the

ray, and the third approximates the tip. Every plate carries a large spine, which is more or less flattened and widened at the tip; these spines may be 3 mm. long and over a millimetre wide at tip. Adambulacral armature diplacanthid, the inner spine on each plate is shorter, more slender, and more cylindrical than the outer, which is 2·5 mm. long, somewhat flattened, especially at tip, where it is also widened. No pedicellariae on any spines, but many small ones within the furrow and on the oral surface of rays, at least near tip. Oral plates narrow, compressed, each with three large, flattened spines, somewhat widened at tip, and one or two big, straight pedicellariae at the oral end. Colour (dry), very light yellowish or dirty white.

Holotype: Reg. No. E. 441.

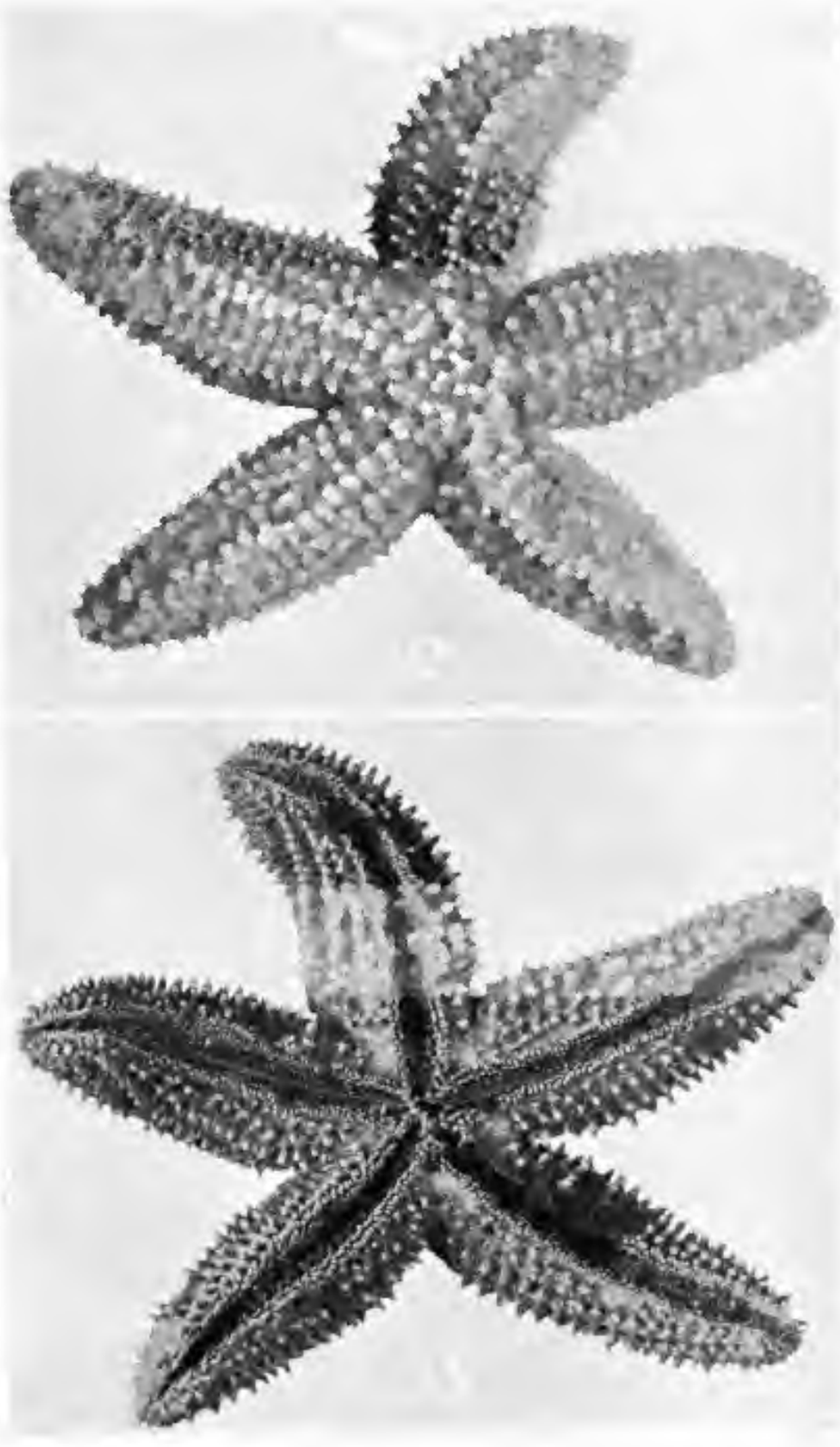
There are five dry specimens of this form, all adult, and showing little diversity in size or form. R ranges from 52 mm. to 82 mm. The chief diversity shown is in the spines, which range from low and distinctly capitate to long, cylindrical, and pointed. The contrast between this species and *U. gymnonota* is most striking, not merely because of the spines, but because the skeletal plates in *U. multispina* are so much more delicate and numerous.

The holotype and the smallest specimen were taken in November, 1890, at "Henley Beach," near Adelaide, by C. B. Adcock; two specimens have no locality label; and one very good, large specimen is labelled, "Port River, Field Nat. Exc., Dec., 1901."

### UNIOPHORA OBESA ([18]) sp. nov.

R = 62 mm., r = 16 mm. to 18 mm., br = 18 mm. to 20 mm. at base of ray, about 23 mm. near middle, and 12 mm., 10 mm. from tip; R = 3·5 r, but only 3 br; disk large, nearly flat, with large papular areas; rays five, more or less swollen, but flat or nearly so on the upper surface, with a very wide, blunt tip. Madreporite rather small, about half-way between centre and margin. Skeletal plates arranged as usual in the genus, about as heavy as *U. multispina*, but with larger papular areas; these latter are very conspicuous even on the oral surface of the rays. Carinal plates in a somewhat irregular series, which is quite zig-zag distally; many of these plates are very stout and high, in marked contrast to the neighbouring plates. Superomarginal series nearly as notable as the carinals, but hardly forming the margins of the ray, since the inferomarginals project more or less beyond them. Most of the dorsal plates carry small capitate spines, usually only one on each plate, but on the carinal plates they are distinctly larger, and there may be three or even four on a plate; the most conspicuously capitate have the "heads" 1·5 mm. in diameter; the smallest spines, and some

([18]) *Obesus*=fat, in reference to the short, stout rays.



of the larger ones, are not capitate. Beaded areas on superomarginals very small, sharply defined, and easily seen when plates are clean, but very hard to distinguish in the normal condition when covered with thick skin.

Inferomarginals very similar to superomarginals, and forming the true margin to the ray; each carries a spine about a millimetre long, cylindrical, blunt, scarcely capitate. Actinal plates very similar and similarly armed; more numerous than in other *Uniophoras*, even the innermost series extending beyond the middle of the ray; these innermost plates often carry two spines instead of one. Adambulacral armature diplacanthid, but there is an evident tendency for the inner spine to be smaller than the outer; often it is much smaller, and distally there are a good many plates from which it has disappeared; proximally the outer spine is more than 2 mm. long, flattened slightly at tip, and sometimes widened there. There are no pedicellariae on the adambulacral spines, but within the furrow small ones are plentiful, and they are very numerous all over the oral surface, sides, and back of rays, and on the disk. Oral plates as usual, with three pairs of stout spines, and a big, straight pedicellaria on each inner corner; the spines are 3 mm. long, flattened and more or less widened at tip. Colour (dry), brownish-yellow (typical "museum colour").

Holotype: Reg. No. E. 442.

There are two fine dry specimens from "Rocky Point, Eastern Cove, Kangaroo Island. October 2, 1901." The paratype is almost exactly like the holotype. There are also eight specimens without locality labels, in very poor condition, which I refer to *U. obesa* with some hesitation. They have R = 60 mm. to 100 mm., and all are dried quite flat, so that it is impossible to say whether the arms had the plump appearance of typical *U. obesa*. Oddly enough these specimens intergrade so with *U. gymnonota*, from the same lot and dried in the same way, that faith in the validity of the two species is sadly shaken. I am separating them in this particular lot, chiefly by the appearance of the marginal plates; those with unarmed marginals are, of course, *U. gymnonota*, while those with conspicuous spines on the marginals I am calling *U. obesa*. Probably in fresh or well-preserved material there will be little difficulty in distinguishing the two forms, typical specimens are so unlike. One of the poorly preserved specimens has six rays; it is the only non-pentamerous *Uniophora* I have seen.

## UNIOPHORA SINUSOIDA.

*Asterias sinusoïda* Perrier, Arch. Zool. Exp., iv, 1875, p. 338.
*Uniophora sinusoida* Fisher, Ann. Mag. Nat. Hist., (9) xii, 1923, p. 597.

There are five examples which seem to represent this species, and as it has never been figured, I am giving figures of the largest specimen, which has

R = 75 mm. This specimen has no locality label, but the others were taken by Dr. Verco in Spencer or St. Vincent Gulf. The type locality is Hobart, Tasmania. The present specimens show very little diversity, but all have the distinctive characters of the species well developed. The zig-zag carinal series,

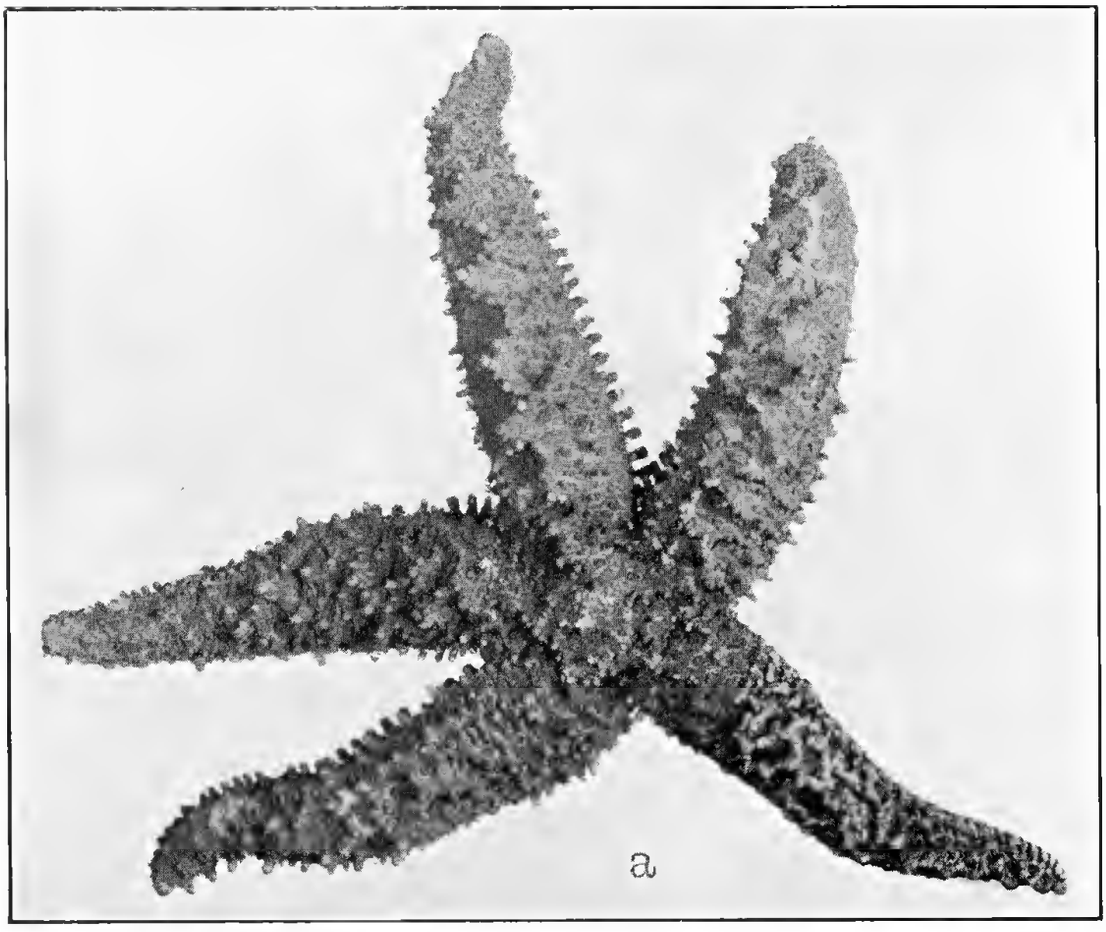



Fig. 121a. *Uniophora sinusoida*, aboral view (slightly reduced).

the marked contrast between the capitate dorsal spines and the flattened, terminally widened spines of the inferomarginal and actinal plates, and the small number of actinal plates, combine to give this species a very characteristic appearance. It may also be noted that there are distally often, if not usually, two spines on each inferomarginal, the distal one generally much smaller than the other. The smallest specimen has R = 30 mm., but is like the larger specimens in all essentials.

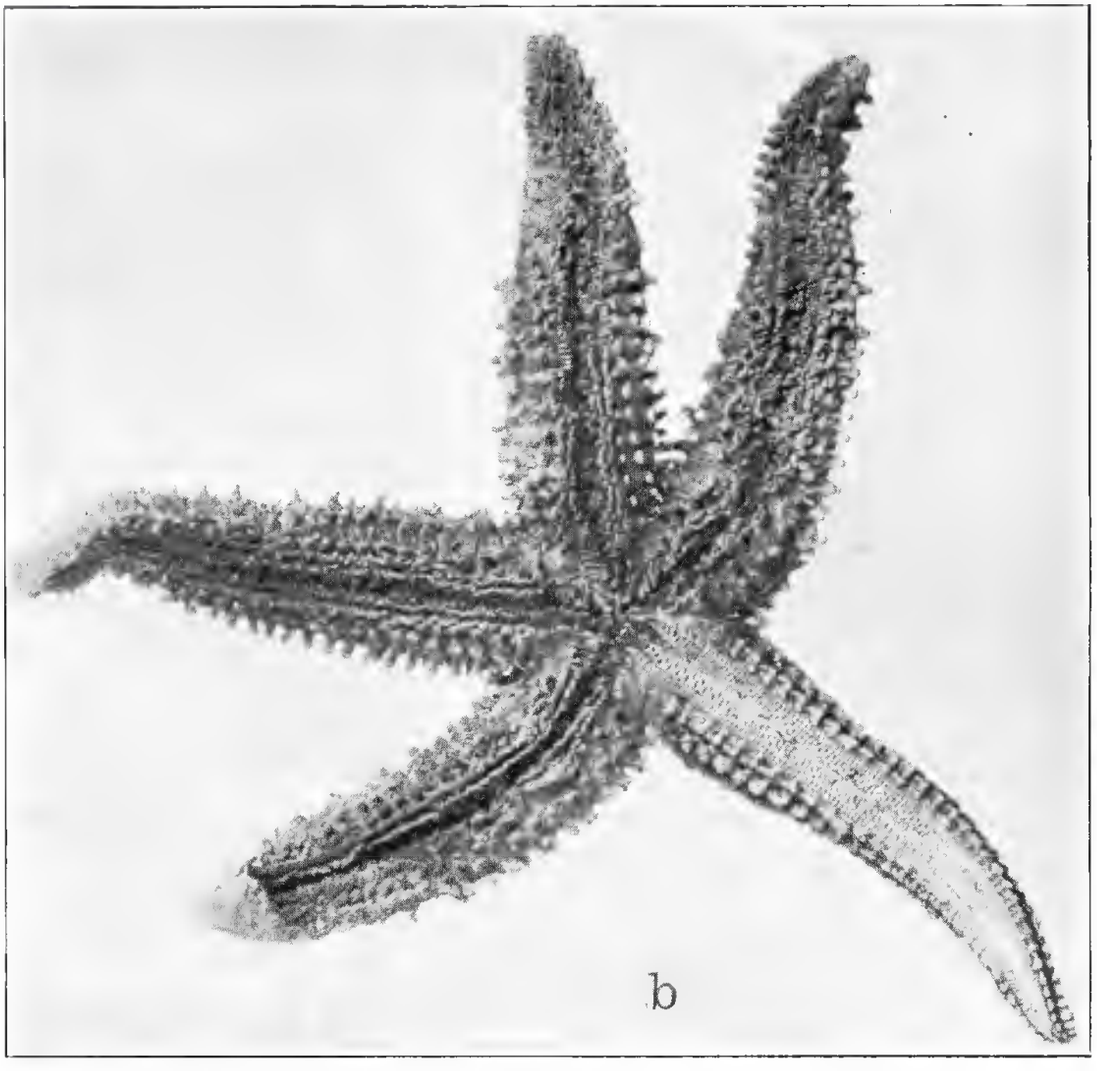



Fig. 121b. *Uniophora sinusoida*, oral view (slightly reduced).

## UNIOPHORA UNISERIALIS (19) sp. nov.

R = 65 mm., r = 13 mm., br = 18 mm. at base, 20 mm. nearer middle, R = 5 r or 3·5 br. Rays five, broad, somewhat tapering, flattened above; disk moderate, rather flat; skeleton rather stout, especially the carinals; madreporite moderate, half-way from centre to margin, surrounded by about ten stout but pointed spines; similar but larger spines are scattered about on the disk. Carinal series with stout but conically pointed spines; not one on every plate, but about fifteen in all on each ray. Superomarginals similar to carinals, forming the margin of the ray, every other one more or less regularly with a spine

(19) *Uniserialis*=having a single series, in reference to the practical absence of dorsolateral spines.

similar to those of carinals; beaded areas conspicuous; dorsolaterals inconspicuous and practically without spines; there are, however, a few small spines here and there. Small pedicellariae abundant all over dorsal surface.

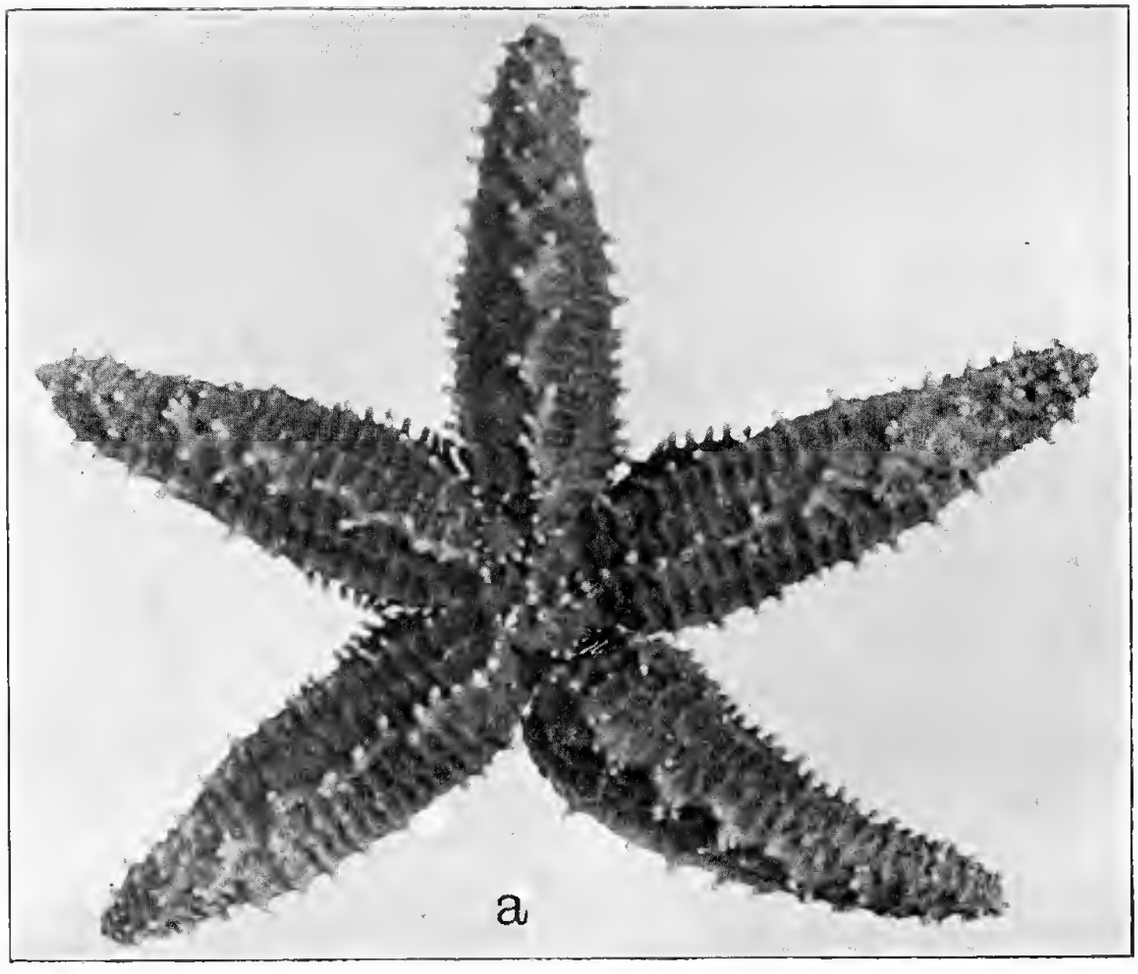



Fig. 122a. *Uniophora uniserialis*, aboral view of holotype (nat. size).

Inferomarginals smaller than superomarginals, and beyond the basal four or five each one (with few exceptions) carries a somewhat flattened spine, rounded at the tip. Actinal plates in only two series, and of these the one next the adambulacrals extends only a little more than a third of the arm-length; each plate carries a conspicuous spine, like those of the inferomarginals, but somewhat more flattened and usually wider at the tip. Adambulacral spines more or less cylindrical and bluntly pointed, but with a good many of the outer series enlarged, flattened, and widened at tip to a greater or less extent. Oral plates, as usual in the genus, but with only two spines on each one, and a big, straight pedicellaria on the inner corner. Numerous small pedicellariae in the

ambulacral furrow, and on the oral surface of the ray. Dry specimens "museum colour"; alcoholic material not essentially different.

Holotype: Reg. No. E. 444.

There are only three specimens to be referred to this species; the holotype described above from St. Vincent Gulf; a similar specimen without locality label; and a young individual, with R = 23 mm., from Dr. Verco's collections

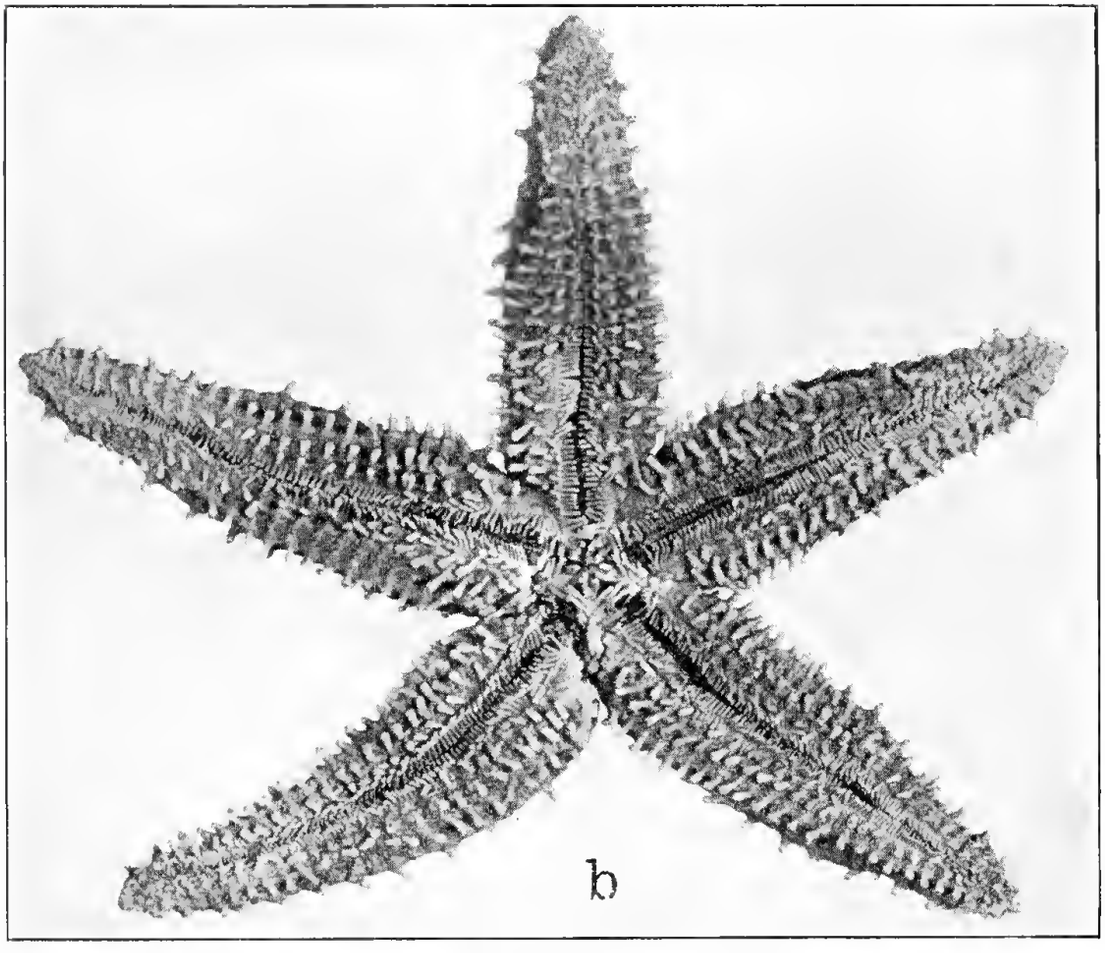



Fig. 122b. *Uniophora uniserialis*, oral view of holotype (nat. size).

in either St. Vincent or Spencer Gulf. The small individual has only one series of actinal plates. The form and distribution of the abactinal spines, the practical lack of dorsolateral spines, and the small number of actinal plates combine to give this species a distinctive appearance.

In view of the notable additions here made to the genus *Uniophora*, it is desirable to give a key to the nine species which are now known. Besides the six listed above, I believe Perrier's *Asterias nuda* and *A. fungifera* ([20]) belong

([20]) Perrier, Arch. Zool. Exp., iv, 1875, pp. 335 and 337.

in this genus, and my own Western Australian species, *U. dyscrita* ([21]) must be included. These various forms may be distinguished from each other as follows, but of course isolated specimens, especially if young or poorly preserved, may give trouble. Moreover, as remarked before, it is very probable that some, perhaps several, of the nine forms here called species are merely varieties or local races, and intermediate specimens will often occur.

## KEY TO THE SPECIES OF *UNIOPHORA*.

a. Large, straight pedicellariae rare or wanting, except on inner end of oral plates.
  b. Dorsal spines conspicuously capitate, globose, or fungiform.
    c. Dorsal, lateral, and actinal spines fungiform, the dorsal spines crowded .. .. .. *fungifera.*
    cc. Spines more or less globose or capitate .. .. *granifera.*
  bb. Dorsal spines of diverse forms, often capitate, but not conspicuously so, and never fungiform.
    d. Spines more or less numerous on dorsal surface, as well as on marginal and actinal plates.
      e. Carinal series of plates and spines conspicuous and well defined.
        f. Carinal series more or less zigzag at least distally; dorsolateral plates generally with spines.
          g. Carinal series conspicuously zigzag, except near disk, its spines capitate, particularly the large ones; carinal and dorsolateral series forming a double series of large polygonal areas .. *sinusoïda.*
          gg. Carinal series zigzag only distally, or if zigzag proximally its spines not capitate; no double series of large polygonal areas on dorsal surface of rays, but two series of smaller areas on each side of carinals.
            h. Arms relatively short and stout; most dorsal spines small and capitate .. .. *obesa.*
            hh. Arms longer, tapering; dorsal spines numerous, long, not capitate .. .. .. *multispina.*
        ff. Carinal series nearly or quite straight, not more than one spine to a plate; dorsolateral spines practically wanting .. .. .. *uniserialis.*

([21]) H. L. Clark, Journ. Linn. Soc., Zool., xxxv, 1923, p. 244.

ee. Carinal series inconspicuous and incomplete; spines of inferomarginal and actinal plates flattened, with tips chisel-shaped, or deeply channelled on upper surface, or even divided into two or three short branches .. *dyscrita.*

dd. Spines relatively few, wanting dorsally and on marginals except near tip of ray; more or less numerous, but often nearly wanting, on actinal plates .. .. .. *gymnonota.*

aa. Large, straight pedicellariae, numerous both in the ambulacral furrow and external to the adambulacral spines *nuda.*

Perrier gives "Port Lincoln (détroit de Torres)" as the locality for *Uniophora nuda*, of which I have never seen a specimen. No doubt Port Lincoln, South Australia, is the correct locality, for not only is there no Port Lincoln in the Torres Strait region, but no sea-star of the family Asteriidae occurs on the northern coast of Australia.

## OPHIUROIDEA

There are 503 brittle-stars in the collection, representing forty-one species and one variety, but three specimens, representing the following three species, are non-Australian:

*Gorgonocephalus caputmedusae* (L.).
*Gorgonocephalus lamarckii* (M. & T.).
*Ophioderma longicaudum* (Retz).

No further reference will be made to these species.

Of the remaining thirty-nine forms, thirteen species and one variety are described as new, while one more species, an *Ophioscolex*, may prove to be new, but the only specimen in the collection is in such poor condition that no satisfactory distinctive characters can be made out. Three other species, *Astrochalcis tuberculosus*, *Ophiura oöplax*, and *Ophiozonella elevata*, are now recorded from Australia for the first time. One of the new species represents a very striking new genus, of the family Ophiolepididae, and shows aborally features reminding one of the West Indian genus *Ophiothyreus*, but is entirely different orally.

Of the thirty-nine forms, thirty-one are certainly from the southern coasts of South Australia, while eight are probably, in spite of labels to the contrary or entire lack of labels, from the waters of the Northern Territory; all but one of these are well-known tropical species, and there is no probability that any one of them occurs on the southern side of the continent.

Nearly a third of the 503 specimens represent the ubiquitous and perplexing

genus *Ophiothrix*, while more than half the remainder belong to *Ophiomyxa*, *Ophionereis*, *Pectinura*, or the new genus *Ophiocrossota*. Seven species, of which five, and possibly six (if the *Ophioscolex* already referred to is included) are new, are represented by only a single specimen each.

The occurrence of a new species of *Ophiocomina*, a genus hitherto monotypic, and known only from European and neighbouring seas, has enabled me to take up anew the question of the affinities of that genus, hitherto regarded in Europe as one of the Ophiocomidae. There can be no longer any doubt, I think, that it is not a representative of that family, but is almost certainly one of the Ophiacanthidae.

## ORDER PHRYNOPHIURIDA

### FAMILY OPHIOMYXIDAE.

#### OPHIOMYXA Müller & Troschel.

#### OPHIOMYXA AUSTRALIS.

Lütken, Add. ad Hist. Oph., pt. iii, 1869, p. 45.

There are forty-eight specimens of this well-known species, chiefly from St. Vincent and Spencer Gulfs. A few have more definite localities: Yorke Peninsula, Salt Creek, Coobowie, March 31, 1885, Mrs. E. Davie; Port Willunga; Port Vincent, and Tumby Bay. The smallest specimens are 10 mm. to 12 mm. across the disk, and the largest are 23 mm. to 25 mm. Apparently there is considerable diversity of colour in life, for even the alcoholic specimens are more or less unlike each other. The arms are often conspicuously banded, and occasionally the disk is adorned with large dark spots, 1·5 mm. to 2 mm. across. There are five arm-spines, or frequently only four in small specimens, and five, six, or rarely seven in the large ones.

#### OPHIOSCOLEX Müller & Troschel.

#### OPHIOSCOLEX sp. ?

There is an *Ophioscolex* with disk about 6 mm. across, and three arms about 20 mm. long, which resembles the European *O. glacialis* M. & T. so closely that I am unable to find a single character by which it can be distinguished. It is in such poor condition, however, that I am unwilling to identify it with a species whose occurrence in South Australian waters is so highly improbable. This specimen was collected by Dr. Verco in Spencer or St. Vincent Gulf.

## FAMILY GORGONOCEPHALIDAE.

### ASTROCONUS Döderlein.

### ASTROCONUS AUSTRALIS.

*Astrophyton australe* Verrill, Bull. U.S. Nat. Mus., iii, 1876, p. 74.
*Astroconus australis* Döderlein, Jap. Euryalae, 1911, p. 36.

Fifteen specimens of this characteristic species are chiefly without locality labels; some are from St. Vincent and Spencer Gulfs, and there is one from Encounter Bay and one from Edithburg, gift of J. G. McDougall. The smallest specimen is only 8 mm. across the disk; there is a prominent knob at the inner end of each pair of radial shields, and two or three smaller ones near the outer margins; no knobs have yet developed on the arms. The largest specimen is 35 mm. across the disk, and the arms probably exceed 125 mm. There are relatively few knobs or tubercles on the radial "wedges" of the disk, but a good many on the basal portion of the arms. The colouration is very handsome, the depressed areas and lines on the disk and between the joints of the arms being dull purplish-brown in contrast with the pale yellowish-brown ground colour. One of the other specimens shows a tendency towards the same type of colour pattern, but the rest are uniformly whitish or light yellow-brown or red-brown.

There is the greatest diversity, quite apart from size, in the development of the tubercles, and also in the approximation of the radial ribs to each other, with the consequent development of radial "wedges." At one extreme are specimens with very few and small tubercles and narrow, widely separated radial ribs; at the other are individuals with numerous tubercles, often very large on the disk, and thick, approximated radial ribs, which so nearly monopolize the upper surface of the disk that the interradial areas are practically wanting, being reduced to mere furrows between the radial "wedges." Only the presence of many connecting forms convinces one that the two extremes really belong to a single species. While the extreme with radial "wedges" approaches *Conocladus*, the tubercles are very different from those of that genus, and the distinction between disk and arms is never wholly lost.

This Euryalid seems to find a congenial home on various sponges. Half a dozen of the present specimens are preserved in close association with the sponge upon which they were living, and apparently at least four species of sponges are represented among the six specimens.

### ASTROBOA Döderlein.

### ASTROBOA ERNAE.

Döderlein, Jap. Euryalae, 1911, p. 82.

It is interesting to find this Western Australian species occurring on the

coast of South Australia. While three of the six specimens in the present collections have no locality labels, the others are designated as from Kangaroo Island, Edithburg, and Victor Harbour. The Kangaroo Island specimen was presented in 1885 by Mr. Mollineux, that from Edithburg in 1897 by Mr. W. W. Cothell, and that from Victor Harbour, January 26, 1903, by Mr. George Jeffrey, harbour master. This Victor Harbour specimen is about 50 mm. across the disk, and the arms are about 200 mm. long. In colour the disk is reddish-brown, the radial ribs and the arms of a lighter greyish-brown. The other specimens are the usual "museum colour."

### ASTROCHALCIS Koehler.

### ASTROCHALCIS TUBERCULOSUS.

Koehler, Siboga Rep., Mon., xlv b, 1905, p. 130.

It is unfortunate that neither of the two specimens in the present collection has a locality label, for this is an East Indian species, and has not been recorded from Australia. While it is not impossible that these individuals were taken in Spencer or St. Vincent Gulf by Dr. Verco, it seems more likely that they are from the coast of the Northern Territory.

The two specimens are superficially quite unlike, but it is probable that their differences come within the range of diversity in the species. One specimen is light yellow-brown, with a disk 40 mm. across, and the upper surface of disk and arms out to the fourth or even the fifth fork bears numerous, big, hemispherical, smooth tubercles, 2 mm. to 4 mm. in diameter. The other individual is a much brighter brown in colour, and the tubercles are much less numerous and mostly smaller, particularly on the arms, where they are small and low, and extend little, if at all, beyond the second fork.

## FAMILY OPHIACANTHIDAE.

### OPHIACANTHA Müller & Troschel.

### OPHIACANTHA BRACHYGNATHA [22] sp. nov.

Disk 6 mm. in diameter; arms 40 mm. to 45 mm. long. Disk covered with minute scales, nearly all of which bear a single stump or crochet, terminating in two to five (usually four or five) acute glassy thorns, more or less flaring, and only clearly visible under considerable magnification. Radial shields completely concealed. Upper arm-plates widely separated, bell-shaped, longer than even the distal width, with distal margin markedly convex.

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[22] *βραχύς*=short + *γνάθος*=jaw, in reference to the unusually short, wide jaws.

Interbraehial areas below eovered with plates a trifle larger than those of the disk; near the oral shields these plates are bare, but near the margin each carries a thorny stump, as on the upper surfaee of disk; in the holotype few of the plates carry the stumps, but in the paratype nearly all do so. Genital slits eonspicuous, reaching nearly to margin. Oral shields moderate, wider than

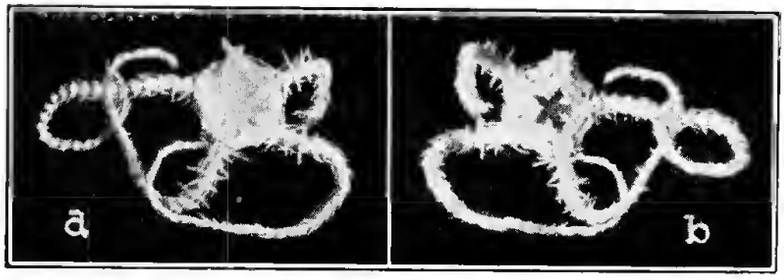


Fig. 123. *Ophiacantha brachygnatha*; a, aboral view; b, oral view of holotype (x 2).

long, with a strongly eonvex distal margin and a sharp proximal angle; the two inner sides are very slightly coneave. Adoral plates large, eurved, three times as long as wide, meeting widely within, but separated distally by the first under arm-plate; oral shields, adoral plates, and basal under arm-plates with a rather coarsely granular surface. Oral plates very small, eaeh with three oral papillae and an unpaired one at the median line; the outer one on eaeh side is flattened, wide, and rounded at tip; the others are about as wide as thiek and are pointed; under the microseope they are finely thorny; the unpaired one is stoutest, the one next to the outermost is most slender. There are four flat, rounded teeth, uppermost widest; no tooth papillae.

First under arm-plate small, rounded pentagonal, outer portion much narrower than inner; seeond plate large, triangular, wider than long, with convex distal margin; sueeeeding plates deereasing in size and relative width, becoming more and more pentangular, with proximal angle less and less evident; all are widely separated from each other. Side arm-plates large, longer than high, espeeially distally, flaring at distal end, where each earries six or five slender, opaque, pointed spines, the uppermost longest, and equal to rather less than two arm-segments, the lower ones suecessively shorter; under high magnification the spines are very finely thorny, but they appear smooth to the unaided eye. Tentaele-seale small, rough, pointed. Colour (dry), nearly white.

Holotype: Reg. No. E. 453.

There are only two speeimens of this new little brittle-star, and the paratype is only 4 mm. aeross the disk. They were taken in Spencer or St. Vineent Gulf by Dr. Vereo. The disk eovering, eoneealed radial shields, very short and wide jaws with spiniform oral papillae, and five or six opaque, pointed,

apparently smooth arm-spines make a combination of characters that will serve to distinguish this species from any other member of the genus, and especially from any other Australian brittle-star.

## OPHIOCOMINA Koehler.

### OPHIOCOMINA AUSTRALIS ([23]) sp. nov.

Text figs. 32, 33.

Disk 12 mm. in diameter; arms 50 mm. to 60 mm. long. Disk completely covered by a coat of very fine granules, one hundred to one hundred and fifty or more per sq. mm., which conceals the underlying covering of delicate scales, and even extends out a little on to the bases of the arms. Upper arm-plates fan-shaped, with distal margin more or less convex, lateral margins strongly diverging distally, proximal margin about one-third of distal; plates wider than long near base of arm, but becoming longer than wide distally, in contact throughout, except at very tip of arm.

Interbrachial areas below completely covered with fine granules, like those of disk. Oral shields somewhat diversified in form in different individuals. In large typical specimens they are wider than long, rhombic, or with distal angle somewhat truncate, making them pentagonal, all the angles, except the proximal, more or less considerably rounded; in other specimens, especially small ones, the length more nearly equals the breadth, and the shape is oval or more like a spear-head. Adoral plates long and narrow, typically meeting within, somewhat enlarged at outer end, where the first under arm-plate separates them. Oral plates large, each with five or sometimes six oral papillae, of which the innermost is the narrowest and most pointed, the outermost is widest, flattest, most rounded, and scale-like. At the tip of the jaw is an unpaired (rarely paired) papilla, like the innermost oral papillae, but smaller; above (below with the specimen upside down, of course) this is a pair (very rarely three) of similar but larger papillae, and above these come the narrow teeth, in the usual single column; rarely another pair of papillae, or possibly a pair of teeth, side by side, occur between the lowest tooth and the oral papillae.

Under arm-plates not peculiar; basally the width tends to exceed the length, but distally the reverse is true; distal margin and corners rounded; lateral margins usually more or less strongly concave; plates broadly in contact throughout. Side arm-plates rather small, but each carries, five, six, or near base of arm seven, long, delicate, blunt, hollow arm-spines, the lower ones equal to about two arm-segments, the upper ones nearly or quite equalling three; uppermost

([23]) *Australis*=southern, in reference to the distribution, the other species of the genus being European.

spines often, if not always, slightly widened at tips; all the spines are more or less flattened, especially at the tip. Tentacle-scale single, oval, flat, rather large, its length about half that of an under arm-plate.

Colour of holotype nearly white, without any distinctive tint or markings; it is probably bleached. The largest paratype is similar, but has a rosy tinge; in two other specimens the disk is distinctly rosy or pinkish, and the arms are variegated with shades of grey, giving the impression of an indefinite banding; the upper arm-spines are lightly ringed or spotted with a dusky shade. In other cases the disk is light brown, usually somewhat mottled with a dull greenish shade, and the arms are pale brown, with more or less evident indications of banding. It is evident, therefore, that there is considerable diversity of colour in life.


Fig. 124. *Ophiocomina australis*; a, aboral view; b, oral view of holotype (nat. size).

Holotype: Reg. No. E. 454.

The paratypes are all considerably smaller than the holotype, the largest being 10 mm. across the disk, with arms less than 40 mm. long; the others range from 6 mm. to 8 mm. across the disk. In most specimens the outline of the disk is circular, but in several it is distinctly pentagonal. Aside from this and the diversity of colour, the sixteen specimens are all very much alike. All were taken in Spencer or St. Vincent Gulf, two near Trowbridge Island, five between Trowbridge Lighthouse and Backstairs Passage, and three at Port Vincent. There is a superficial resemblance between this interesting species and young individuals of *Ophiocoma canaliculata*, but the latter has two tentacle-scales, a group of dental papillae at the tip of each jaw, and (in young individuals) only five arm-spines.

The occurrence of *Ophiocomina* in the waters of southern Australia is of

exceptional interest. The genus was established by Koehler in 1921 ([24]) for a European species long known as *Ophiocoma nigra*. In 1915 ([25]) I placed this ophiuran in *Ophiacantha*, as it is evident enough that it is not an *Ophiocoma;* I also re-established its earlier name of *O. sphaerulata*. In his fine report of 1922 Koehler ([26]) gives a more detailed account of his new genus, and points out its essential characters. In 1920 Mortensen ([27]) had already adopted Koehler's name in a vigorous attack on my position. He holds very strongly to the old name, *O. nigra*, and is very sure the genus is related to *Ophiocoma* rather than to *Ophiacantha*. This is not the place to discuss the proper name of the European species; I must, however, say, that I do not find Mortensen's argument convincing; as I have no doubt that Pennant refers to the species under discussion, I must use his name, since it is the earliest.

But the question of the position of the genus is much more important, and neither of my good friends has really given serious consideration to the most important points with reference to *Ophiocomina*. The first of these is the character of the arm-spines, heavy and solid in all the Ophiocomidae, but fragile and hollow in *Ophiocomina*, as in many *Ophiacanthidae;* in fact, arm-spines like those of *Ophiocomina* are not known among brittle-stars anywhere except in the Ophiacanthidae. Again, the mouth-parts of *Ophiocomina* are not at all like *Ophiocoma*, as both Mortensen and Koehler persist in asserting; there are no dental papillae, but only a few oral papillae at the tip of the jaw, just as happens in some ophiacanthids; moreover, as Mortensen himself has pointed out, the teeth of *Ophiocomina* are not broad and hyaline-tipped, as in *Ophiocoma,* but are narrow and rounded, without a peculiar tip, just as in most ophiacanthids. Finally, *Ophiocoma* and all its allies are strictly littoral, tropical forms, and the occurrence of a member of that family in cool water, at more or less considerable depths, on the north European coasts, would be most extraordinary; on the other hand the Ophiacanthidae have a world-wide distribution in waters of all depths and temperatures. It is perfectly incomprehensible to me how any zoologist, and particularly such experienced and competent students of echinoderms as my highly regarded European friends, could compare *Ophiocomina* with the Ophiocomidae on the one hand, and the Ophiacanthidae on the other, and not readily see the ophiacanthid affinity of the genus.

Comparison of the new species from Australia with the European species of *Ophiocomina* reveals but one important difference; in *O. australis* there is a single tentacle scale, while in *O. sphaerulata* there are two. The European

(24) Koehler, Faune de France, 1912, p. 93.
(25) H. L. Clark, Mem. M.C.Z., xxv, 1915, p. 205.
(26) Koehler, Bull. 100 U.S. Nat. Mus., v, 1922, p. 316.
(27) Mortensen, Vid. Med., lxxii, 1920, p. 50.

speeies is mueh the larger, but has only six arm-spines, while the Anstralian has seven at the base of the arm. The eolour of *O. sphaerulata* seems to be in general mueh darker than that of *O. australis,* but light, and even bright, coloured forms are known. On the whole the resemblance between alcoholie speeimens of the two speeies, when of approximately the same size, is quite striking, except for the tentaele-seales.

## ORDER GNATHOPHIURIDA

### FAMILY AMPHIURIDAE.

#### AMPHIURA Forbes.

#### AMPHIURA TRISACANTHA (28) sp. nov.

Disk 9 mm. in diameter; arms all missing save for the basal part of one, whieh is 20 mm. long and 1·5 mm. wide, not ineluding the spines. Disk eovered with eoat of very fine overlapping scales, among whieh the primary plates can be distinguished only with diffieulty; scales eoarsest near radial shields, whieh are 2 mm. long but not ·5 mm. wide, separated from eaeh other throughout but more widely so proximally, some of the intervening seales being remarkably elongated and narrow, and lying more or less parallel to radial shields. Upper arm-plates twice as broad as long, or broader, narrower proximally, fully in contaet, outer margins rounded, but tending to form an angle at distal corners.

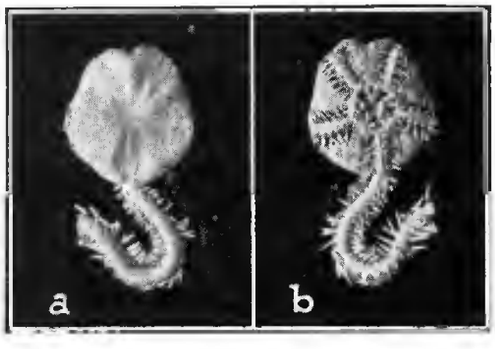


Fig. 125. *Amphiura trisacantha*; a, aboral view; b, oral view of holotype (x 2).

Interbraehial areas below with exceedingly numerous, fine, crowded seales. Oral shields more or less rhombie, length and breadth about equal, angles truncate or rounded; madreporite somewhat larger than others. Adoral plates small, narrow, not in eontaet at either end; radial end wider and rounded; inner end

(28) *τρίς*=thriee+*ἄκανθα*=spine, in reference to the number of arm spines.

pointed. Oral plates well developed, each with two oral papillae; inner block like as usual in *Amphiura,* outer large, oval, like the tentaele-seales, but twiee as big. Second pair of oral tentacles very large.

Under arm-plates squarish or a trifle longer than wide, with rounded corners, and even distal margin, fully in contact. Side arm-plates small, but each earries three opaque, narrow arm-spines, tapering, but blunt and a little flattened; lowest longest, uppermost shortest, but there is no striking differenee between them. At very base of arm there may be four or even five spines, but the upper ones are very small. Tentacle-scale single, moderate, flat, oval.

Holotype: Reg. No. E. 455.

The unique holotype of this speeies was taken by Dr. Verco in either Speneer or St. Vincent Gulf. It is very different from any other Australian *Amphiurid*, and the curious scaling of the disk, combined with the eharacters shown by the arm-plates and spines, gives the species a very characteristic facies, even in this large and widespread genus.

## AMPHIODIA Verrill.

### AMPHIODIA MESOPOMA.

H. L. Clark, Mem. M.C.Z., xxv, 1915, p. 247.

It is not surprising to find nine specimens of this speeies in the present collection, although the type came from Torres Strait, for the Museum of Comparative Zoölogy has a number of specimens taken at Westernport, Victoria, by the late Mr. J. Gabriel in 1914-15 ([29]). The South Australian speeimens are all either from the Verco collections in Spencer and St. Vincent Gulfs, or they have no locality label. One has the interesting note with it: "Caught at night, trawling. Sept., 85 (blue light)." The smallest individual is 4 mm. across the disk; the largest is 7 mm., or equal to the holotype. Compared with that Torres Strait specimen, the disk scaling is somewhat less coarse, and the middle arm-spine less truneate, but the speeimens from Westernport are almost exaetly like the type, so I do not think there can be any doubt about the Torres Strait specimen and those from the southern coasts of Australia being actually identical. The arms in the holotype were broken, and I over estimated their length, I believe, for it is probable that they are usually six or seven times the disk diameter, hardly eight times, as stated in my original deseription. Some of the South Australian and Victorian speeimens retain enough of their original eolour to show that the arms are often, if not always, banded and marked more or less irregularly with yellow. The disk is grey.

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([29]) H. L. Clark, Bull. M.C.Z., lxii, 1918, p. 287.

## OPHIACTIS Lütken.

### OPHIACTIS RESILIENS.

Lyman, Bull. M.C.Z., vi, 1879, p. 36.

This well-known Australian brittle-star is represented by seven specimens from the Vereo collections in Spencer and St. Vincent Gulfs. They are all adults, 6 mm. to 7 mm. across the disk. Their chief interest lies in the fact that in several (one in particular) the interbrachial areas below are more or less conspicuously naked, and are not covered with plates, as is usually the case in the species. This raises the question whether this particular feature is not more or less seasonal, associated with breeding. At any rate, too much stress must not be laid on it as a character distinguishing species from each other.

### OPHIACTIS TRICOLOR ([30]) sp. nov.

Disk 7 mm. in diameter; arms about 25 mm. long. Disk covered with coarse, overlapping scales, but without spinelets or granules of any sort. Radial shields small, their width about one-half their length, which is itself less than one-half the disk radius; they are well separated proximally, but distally are in contact or only a little apart. Upper arm-plates more or less fan-shaped, with distal margin straight or nearly so, and distal corners rounded; they are broadly in contact on the basal part of the arm, but distally become less and less so, and at tip of arm are quite separate.

Interbrachial areas below covered with scales, much smaller than those of the disk; especially near the mouth they are very fine and crowded. Genital slits long and moderately conspicuous. Oral shields triangular or pentagonal with rounded angles, or more or less oval, elliptical, or circular, according to the degree to which the angles are rounded; madreporite usually conspicuous, about as long as wide; the other shields are commonly wider than long. Adoral plates not very large, more or less triangular, in contact radially, separating the first and second under arm-plates, not in contact in front of oral shield; distal angle separates oral shield from side arm-plate. Oral plates very small, each one completely overshadowed by the huge flat, fan-shaped, oral papilla, which is larger than the first under arm-plate. Teeth three or four in each series, thick and massive, lowest (outermost) smallest, uppermost (innermost) largest.

Under arm-plates squarish or slightly pentagonal with rounded angles, more or less in contact throughout, as wide as long (or wider) except distally (near tip of arm), and often the most proximal two or three; first plate very

([30]) In reference to the red, white, and blue colouration.

small, separated from the second by the adoral plates. Side arm-plates rather large, each with three, or at very base of arm four, short, thick, bluntly pointed arm-spines; lowest smallest, others subequal, but uppermost often slightly largest. Tentacle-scale single, oval, moderately large, its length about one-third that of under arm-plate. Colour: disk, pale grey; arms, pinkish-white, with irregular, ill-defined bands of rosy-red and dull blue; blue is all on basal half of arm; red bands show on oral side of arms, and may be quite distinct there, especially distally.

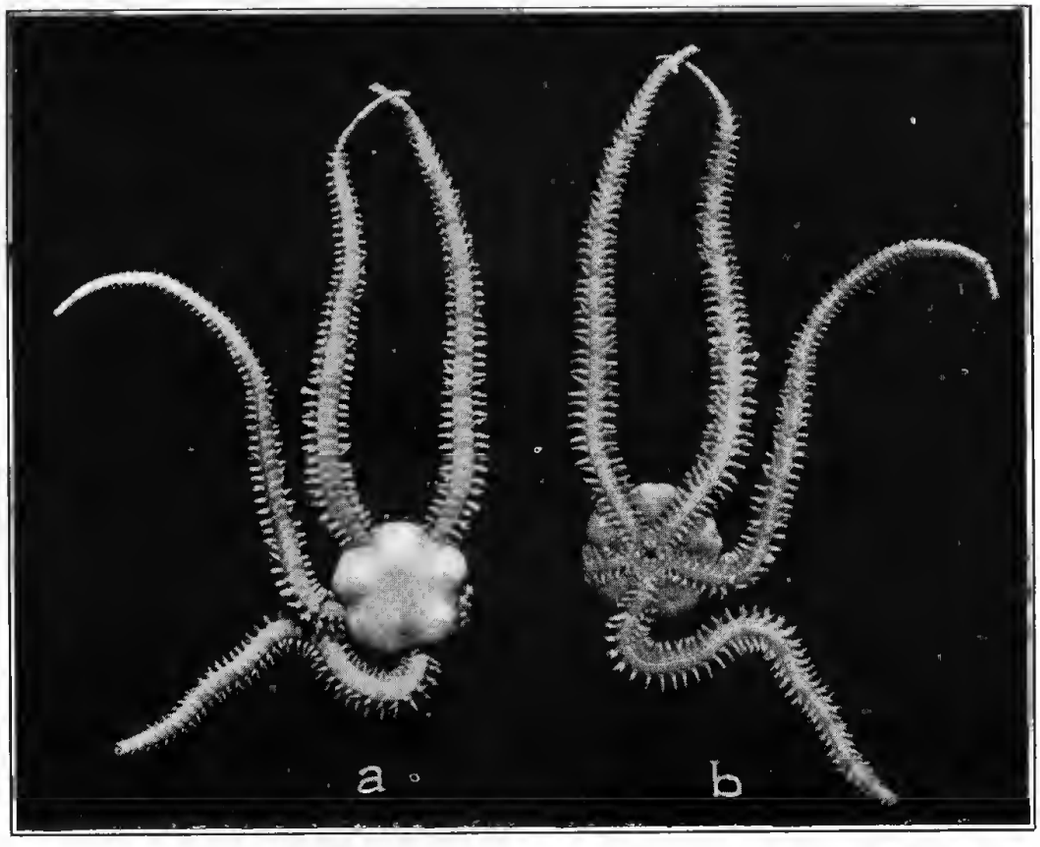


Fig. 126. *Ophiactis tricolor;* a, aboral view; b, oral view of holotype (x 2).

Holotype: Reg. No. E. 458.

There are eleven specimens from Dr. Verco's collections in St. Vincent and Spencer Gulfs. The smallest is 3 mm. across the disk, while the holotype is largest. There is little diversity in the structural features, but there is much in the colouration. The amphiurid-like disk, the dense scaling of the interbrachial areas, and the single, huge, oral papillae are very characteristic, and distinguish the specimens at a glance from *O. resiliens.* The relationship indeed is closer with the *O. plana—O. luteomaculata* group, but *O. tricolor* is very different from any of them.

One of the larger specimens has the upper arm-plates somewhat wider than in the holotype, but even when widest they are still "truncated fan-shaped" rather than elliptical. The specimen is further peculiar in its lack of distinctive colouration, the whole animal being dirty-yellowish, the arms showing only the faintest traces of banding, but it is quite likely that alcoholic bleaching is the explanation of this condition. The other specimens all show arm-banding more or less conspicuously, but the amount of blue on the basal parts of the arm is subject to great diversity. In most cases the blue has a greyish tinge, but now and then it is greenish, and in one specimen would be more naturally called dull green. Occasionally the red markings are tinged with purple, but usually they are very distinctly rosy. Usually the disk is unmarked, but in one specimen it is conspicuously spotted with dull blue. It is probable that the colours in life are much brighter than those exhibited by the present specimens.

## FAMILY OPHIOTHRICHIDAE.

### OPHIOTHRIX Müller & Troschel.

### OPHIOTHRIX ALBOSTRIATA ([31]) sp. nov.

Disk 10 mm. in diameter; arms 50 mm. to 55 mm. long. Disk covered, except radial shields, with blunt, opaque, thick spinelets, only two to three times as long as thick, nearly smooth, and not at all thorny. Radial shields large, close together, but not in contact, nearly twice as long as wide, rounded triangular, perfectly bare and smooth. Upper arm-plates pentagonal at base of arm, and nearly as long as wide, but rapidly becoming oval or elliptical or rounded triangular, broadly in contact.

Interbrachial spaces below well covered with spinelets like those of the disk. Oral shields large, rounded pentagonal, about as long as wide. Adoral plates rather large, not meeting within, but lying one against each inner side of oral shield. Oral tentacles huge. Teeth and tooth-papillae not peculiar. First three basal under arm-plates elongated, narrow, markedly channelled longitudinally; beyond the third the plates become wider than long, with rounded corners, in full contact. Side arm-plates moderately large, each with nine or ten long arm-spines, the uppermost four or five longest and more or less subequal; all are slightly flattened, rough and transparent at tip; some are quite thorny, while others are nearly smooth. Tentacle-scales minute, spiniform, often wanting on the basal pores. Colour very light; disk yellowish-white, with radial shields bluish-white in definite contrast; upper surface of arm with a broad longitudinal

([31]) *Albus*=white+*striatus*=streaked, in reference to the conspicuous line on the arms.

white stripe, faintly bounded with pale yellowish-brown, or distally with grey; this line is probably a conspicuous feature in life, but it may not be white then.

Holotype: Reg. No. E. 459.

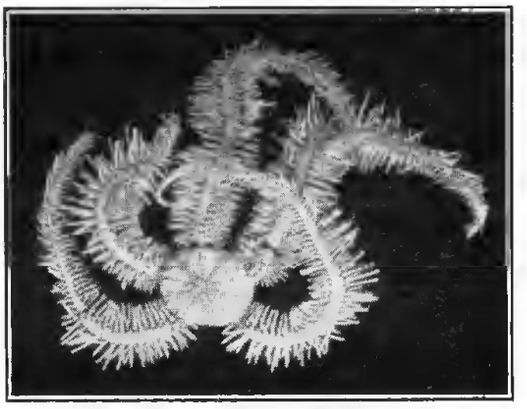

Fig 127. *Ophiothrix albostriata;* aboral view of holotype (nat. size).

A single specimen, said to be from the "Great Australian Bight," is the unique representative of this new species, which is well defined by the character of the disk covering and the curious colouration.

## OPHIOTHRIX ARISTULATA.

Lyman, Bull. M.C.Z., vi, 1879, p. 50.

There are two fine specimens of this handsome brittle-star from Palmerston, Northern Territory, where they were taken in November, 1890. They are about 21 mm. across the disk, and the arms must have been about 125 mm. long. The colour, when dry, is almost pure white. These specimens are the first, I think, to be taken on the north Australian coast.

## OPHIOTHRIX CAESPITOSA.

Lyman, Bull. M.C.Z., vi, 1879, p. 53.

There are sixty-five small specimens of *Ophiothrix* which I am referring to this species. They range from 2 mm. to 7 mm. in disk diameter, and show very great diversity in colour and in the disk covering, as well as in the form of the upper arm-plates. Several seem to be referable to the form to which I gave the name *acestra* ([32]) some years ago, but I am so uncertain now as to the validity of that form that I hesitate to use the name. The question as to whether there is more than one small Ophiothrix, having the disk covered with thorny stumps, with or without sharp spines among them, on the southern

(32) H. L. Clark, Mem. Aust. Mus., iv, 1909, p. 544.

Australian coast can, I think, only be settled on the spot. Nearly all of the present specimens were taken by Dr. Vereo in Spencer or St. Vincent Gulf (some are labelled "Trowbridge Island" and some "between Trowbridge Island Light and Backstairs Passage"), but a few have no locality label. The most conspicuous variety is a form, nearly uniform brown in colour, with a very large number of long, pointed, thorny spines on the disk. While like *O. acestra,* in some ways these individuals have the upper arm spines rather decidedly different, and moreover they seem to intergrade with typical *O. caespitosa,* with which they apparently occurred. The only way in which the actual relationship of these forms can be determined is by careful study of freshly collected material, the actual habitat and ecological conditions of which are known to the investigator.

### OPHIOTHRIX HYMENACANTHA (33) sp. nov.

Disk 8 mm. in diameter, the flattened arms 45 mm. to 50 mm. long and nearly 2 mm. wide at base, apart from the spines. Disk perfectly bare; radial shields large, bare, occupying most of the upper surface; radial scales, between shields, elongated; other scales small but centrodorsal evident. Upper arm-plates

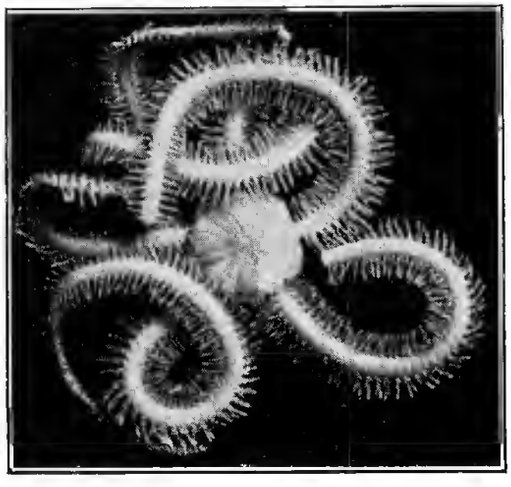

Fig. 128. *Ophiothrix hymenacantha;* aboral view of holotype (x 2).

elliptical, becoming rounded pentagonal distally, much wider than long, especially near base of arm, where width is more than twice the length, broadly in contact.

Interbraehial spaces below covered with minute, thorny spinelets. Oral shields wider than long, but in no way distinctive. Lower arm-plates

(33) *ὑμήν*=a membrane+*ἄκανθα* =a thorn or spine, in reference to the uniting of some arm-spines by a membrane.

wider than long, at least on proximal part of arm, with rounded corners, broadly in contact. Side arm-plates moderate, each with seven or eight spines; uppermost spine (at very base of arm, uppermost two) small, aciculur; the next three as long as two and one-half arm-segments, the upper one pointed, the others with thickened, thorny tips; lowest three spines very small, the lowermost merely a serrate hook; on basal joints of arm the uppermost three or four spines in each series are united to each other by a definite transparent membrane like that in *Ophiopteron*. Tentacle-scales insignificant. Colour pale greyish-white; disk scales, arm-spines, mouth parts, etc., yellowish-white.

Holotype: Reg. No. E. 462.

There is a single dry specimen of this peculiar species, labelled "Great Australian Bight." Its generic position is open to question, for the disk is strikingly like *Ophiotrichoides*, while the basal arm-spines are distinctly suggestive of *Ophiopteron*. In the redefining of these two genera in the break-up of *Ophiothrix*, which is bound to come before long, it is possible that this isolated Australian species may be found to belong in one of them. It is certainly not a typical *Ophiothrix*.

## OPHIOTHRIX LINEOCAERULEA ([34]) sp. nov.

Disk 8 mm. in diameter; arms 45 mm. to 50 mm. or more. Disk, except for radial shields, sparsely covered with blunt, opaque spinelets, which are not themselves thorny. Radial shields very large and bare, covering most of disk. Upper arm-plates broadly in contact, oblong or somewhat pentagonal, wider than long, with convex distal margin, and a shorter, straight or concave proximal one. Oral shields and adoral plates much as in *O. albostriata*, the adorals lying close to the inner margins of the large, rhombic shields. Under arm-plates broadly in contact, tending to be longer than wide, the basal one or two somewhat channelled. Side arm-plates rather large, each with seven (often only six) long, slender, more or less glassy arm-spines, which are rough at tip, though the upper ones are more or less pointed; the longest equal three segments of the arm or more.

Colour, dirty-whitish; inner (adradial) margin of each radial shield deep purplish-blue; distal margin with a more or less incomplete line of the same shade, and a triangular spot of the same colour is more or less in evidence on distal half of each shield, but this may be very faint; apparently continuous with the blue of inner margin of radial shields, two parallel lines of blue run out on dorsal side of each arm, extending to the tip; these are very distinct and well defined. Oral shields, adoral plates, and basal under arm-plates, blue;

([34]) *Linea*=line+*caeruleus*=blue, in reference to the conspicuous markings on the arm.

beyond disk, most under arm-plates have a central area of whitish, so that the under side of the arm seems to have a double line of blue like the dorsal side; these lines, however, are not well separated, but tend to widen and run together on every joint.

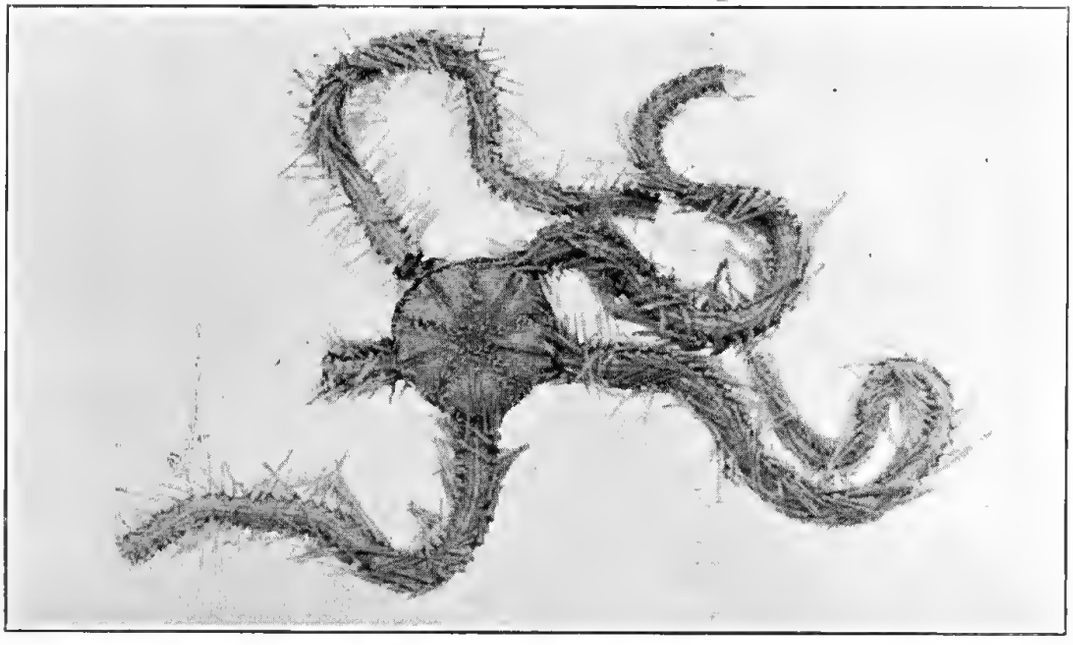

Fig. 129. *Ophiothrix lincocaerulea*; aboral view of holotype (x 2).

Holotype: Reg. No. E. 463.

There is only a single specimen of this handsome *Ophiothrix*, but the colouration is so very distinctive I have no doubt of the validity of the species. In this large and perplexing genus the colour pattern often gives the only reliable species character. Unfortunately there is no locality label with this unique specimen, and hence we cannot be certain that it is from South Australia, but it has the appearance of being from Dr. Verco's collections from Spencer or St. Vincent Gulf, and I feel very little doubt about its locality.

## OPHIOTHRIX LONGIPEDA.

*Ophiura longipeda* Lamarck, Anim. s. Vert., ii, 1816, p. 544.
*Ophiothrix longipeda* Müller & Troschel, Syst. Ast., 1842, p. 113.

There are seven typical specimens of this well-known species, having disks 12 mm. to 14 mm. in diameter and arms 175 mm. long, more or less. Only one has a locality label, "Tumby Bay, South Australia, 28/x/1896." This example, except for being dry, is like the other six, and was probably of the same lot originally, but I very much doubt if any of them came from Tumby Bay.

Probably they are from the Northern Territory, where the species almost certainly occurs, as it is common everywhere on the north-eastern coasts of Australia. It is not known from south of Port Curtis, Queensland, and it is hard to believe that so large and conspicuous a brittle-star could have been overlooked if it occurs along the southern coasts of the continent.

## OPHIOTHRIX MARTENSI AUSTRALIS.

H. L. Clark, Dept. Mar. Biol. Carn. Inst., x, 1921, p. 111.

There are nine specimens of this characteristic Australian subspecies, ranging from 6·5 mm. to 9 mm. across the disk. Aside from the fact that two or three of the alcoholic specimens are very markedly bleached, all are distinctly of the subspecies *australis*. One is labelled as from the Northern Territory, where one would expect the species to occur, five alcoholic specimens have no locality label, and three dry specimens are said to be from "Tumby Bay." It seems to me very unlikely that any form of *O. martensi* occurs on the southern coast of the Australian continent, hence I believe that all these specimens are from the Northern Territory.

## OPHIOTHRIX SPONGICOLA.

Stimpson, Proc. Acad. Nat. Sci. Philadelphia, vii, 1855, p. 385.

There is a fine series of this typically Australian *Ophiothrix*, consisting of seventy-six specimens, ranging from 4 mm. to 19 mm. across the disk. They exhibit a considerable diversity of colour, and the growth changes are important. How much the colour differences are due to preservation it is hard to say. One specimen is very pale brown or dirty-whitish, with deep purple spots on the interbrachial spaces below, and a hint of a similar spot between the radial shields of each pair; otherwise there are no indications of colour, though there are faint traces of marks on the arms. The smallest specimens are very light-coloured, whitish or pale brown, with conspicuous blue or purple marks between the radial shields of each pair, and extending more or less on to the shields, and irregular markings of the same shade at regular intervals on the arms; the intervals are of three segments, which may be all light or only the middle one wholly light, the others more or less included in the coloured areas. In large specimens the blue may completely cover all the upper arm-plates, but usually indications of banding are distinct. The lighter areas of the arms are usually tinged with red, and may be quite red, the arms then being distinctly banded with red and deep purplish-blue. The shade of blue varies greatly from light greyish-blue to almost black. Stimpson's description says the colours are black and red, and it is probable that this is the impression given by many large specimens in life.

The specimen with the disk only 4 mm. across has no spinelets on the disk, except at the very margin, where a few occur; the interbrachial areas below lack scales as well as spinelets. The arms are only about 20 mm. long, or five times the disk diameter. A specimen about 6 mm. across the disk has arms about 40 mm. long, or nearly seven times the disk. Minute spinelets are beginning to appear on the disk scales. In the largest specimen the arms are over 160 mm. long, more than eight times the disk; the latter is rather thickly covered with thorny spinelets, which are even crowded in between the radial shields of a pair; the radial shields themselves are, however, quite bare. As a rule the disk is well covered with low, blunt spinelets, but it is not uncommon to find specimens in which these are wanting, except near the interbrachial margins. In spite of all this diversity in spinulation and colour, the species is easily recognized, at least among the Australian members of the genus.

These specimens are chiefly from the Vereo collections, largely from Spencer and St. Vincent Gulfs. A few are from near Trowbridge Island, or between Backstairs Passage and Trowbridge Lighthouse. There are two from Tumby Bay, and several have no locality label. The species is known to range from the Abrolhos Islands on the west coast of Australia, along the whole southern coast, to Broken Bay on the eastern coast of New South Wales.

## ORDER CHILOPHIURIDA

### FAMILY OPHIOCHITONIDAE.

#### OPHIONEREIS Lütken.

#### OPHIONEREIS SCHAYERI.

*Ophiolepis schayeri* Müller & Troschel, Arch. Naturg. x, 1844, p. 182.
*Ophionereis schayeri* Lütken, Add. ad Hist. Oph., pt. 2, 1859, p. 110.

There is a fine series of twenty-nine specimens of this well-known species, ranging from 7 mm. to 21 mm. across the disk. The diversity in colour is considerable, but is probably in large part artificial. Thus the lightest individual is cream-colour, with faint indications of any markings, even the bands on the arms being indistinct, but it is quite probable that the specimen has been bleached in preservation. Again, the darkest specimen is a rich red-brown, with the usual markings evident but dull; this individual has apparently at some time been in a rusty container, though it is not impossible that the colour is natural. Normally, dry specimens are pale and dark grey of various shades, while alcoholic specimens have a very evident brownish-yellow appearance.

One of the present series, a young specimen 7 mm. across the disk, is labelled "*Ophionereis fasciata* Hutton." There is no locality given, but the label is in every way similar to the labels on certain New Zealand specimens in the collection, and I have little doubt that this specimen came from New Zealand. Mortensen ([35]) is very sure that the New Zealand and Australian forms represent two different species, and he retains the name *O. fasciata* for the New Zealand form. But the differences which he emphasizes are by no means as constant as could be desired, and I am very much in doubt whether the New Zealand *Ophionereis* is really so recognizable as Mortensen thinks. While I have a considerable series of Australian specimens at hand, I have only a few from New Zealand, so I am not ready to reach a final conclusion. Mortensen holds that the Juan Fernandez *Ophionereis* is also different from that occurring in New Zealand. There is but one Juan Fernandez specimen at hand, and it is only half-grown, but it does not incline me towards Mortensen's view. One point to which my esteemed Danish colleague refers demands a careful investigation, namely, the size of the eggs. It is an open question in my mind whether this has the significance which he attributes to it, and I very much doubt its constancy and importance. Certainly the very close relationship of the forms of *Ophionereis* occurring in Australian seas, at New Zealand, and at Juan Fernandez, is beyond question. One striking feature which they have in common, evident even in young specimens, is the occurrence of four arm-spines on the basal arm-segments. This is very constant, and enables one to separate them from the Indo-Pacific species *O. porrecta* very readily. Whether we call them *O. schayeri*, or consider the New Zealand and Juan Fernandez forms subspecies, or even full-fledged species, seems to me relatively unimportant, but, nevertheless, the correct solution of the problem will be interesting. The *Ophionereis* from the Abrolhos Islands, W.A., which I published as *porrecta* ([36]), are undoubtedly small specimens of *schayeri*, as a re-examination shows. Hence this southern form is one of the few typically Australian echinoderms which have reached the Albrohos Islands.

Most of the present specimens were taken in either Spencer or St. Vincent Gulf, but two are from Tumby Bay, and seven very fine ones are from Port Willunga, Zietz collection. There are two specimens labelled "N. Australian coast" which resemble these Port Willunga specimens so closely I have little doubt they are from the same place, if not actually the same lot. There is also a small specimen labelled "Northern Territory" which is undoubtedly from the southern coast of Australia.

([35]) Mortensen, Vid. Med., lxxvii, 1924, p. 164.

([36]) H. L. Clark, Jour. Linn. Soc., Zool., xxxv, 1923, p. 247.

### OPHIONEREIS SEMONI.

*Ophiotriton semoni* Döderlein, Jena. Denkschr., viii, 1896, p. 288.
*Ophionereis semoni* Koehler, Siboga Rep., Mon., xlv b, 1905, p. 54.

It is a matter of great interest to find this little brittle-star common on the coast of South Australia, for it was hitherto recorded in Australia only from the Torres Strait region and Green Island, off Cairns, Queensland. I have already discussed ([37]) the relationship of this species to *O. dubia*, but I may add here my more recent conclusion that the genus *Ophiocrasis* ([38]) is not worth maintaining, as *O. semoni* is such a complete connecting link between it and *Ophionereis;* but a comparison of *semoni* with the two Japanese species of *Ophiocrasis* shows that both are quite distinct from *O. semoni*, which is readily distinguished from all its allies by the skin-covered oral surface, as already described by me ([37]).

The present series of twenty-two specimens of *semoni*, with disks 2·5 mm. to 7·5 mm. across, were all taken by Dr. Verco in St. Vincent and Spencer Gulfs. As they are in five different lots, there does not seem to be any room for doubt about the general locality. Compared with Queensland specimens, the only difference is in the more generally green colouration of those from the north which are distinctly green (more or less of an olive tint) and white, while the southern individuals are brown and white, though the markings on the arms are, in young specimens at least, distinctly greenish. The disk is brown with a white reticulation (curved lines), or white with a brown reticulation of the same character, or dark brown reticulated with a light shade. When dry all the tints become greyish, and there is no indication of green. One striking feature of the colouration, evident in both northern and southern specimens, is found in the white oral shields, surrounded by a greenish or brownish circle. If more abundant material shows that the northern specimens are typically green and white, and the southern brown and white, with a very definite constancy, the latter might well be designated by a subspecific name.

## FAMILY OPHIOCOMIDAE.

### OPHIOCOMA Agassiz.

### OPHIOCOMA CANALICULATA.

Lütken, Add. ad Hist. Oph., pt. 3, 1869, pp. 46, 99.

A good series of fourteen specimens of this rare species shows that it is not infrequent on the coast of South Australia. There are two specimens

([37]) H. L. Clark, Dept. Mar. Biol., Carn. Inst., x, 1921, p. 118.
([38]) H. L. Clark, Bull. U.S. Nat. Mus., lxxv, 1911, p. 175.

without locality labels and one specimen from Edithburg; all the others are from Spencer or St. Vincent Gulf, and for most of them we have to thank Dr. Verco. The smallest individual is little more than 6 mm. across the disk, and the arms are only about 22 mm.; the colour is dark grey with a slight purplish tinge; on the upper side of the arms are a few, irregular, widely scattered white marks; the under side of the arms is grey, with a broad, median white band, and the arm-spines are pale grey; for the most part there are but four arm-spines, but basally there are five, and on one or two joints there are six. Another specimen 7 mm. across the disk, with arms 30 mm. long, also has four and five arm-spines; it is pale brown in colour, with distinct but faint indications of dusky bands on the arms; the under side of the arms shows the broad median white band of the darker specimen. Both these young individuals have the granulation of the disk much finer and denser than in adults; there are at least 80 to 100 granules per sq. mm., but the interbrachial areas below are as bare and free from granules as in the adults.

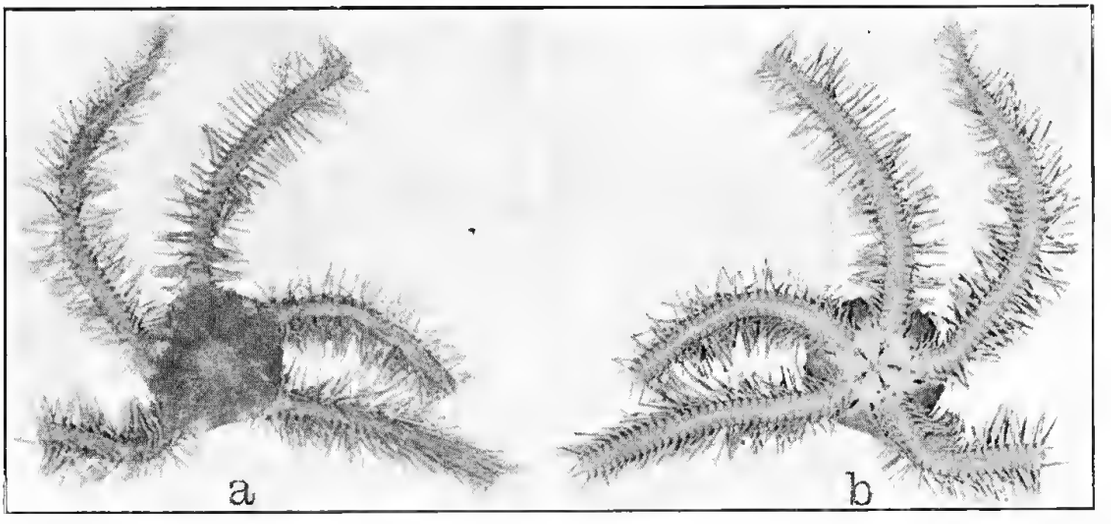


Fig. 130. *Ophiocoma canaliculata;* a, aboral view; b, oral view (nat. size).

The largest specimen is 21 mm. across the disk, but all the arms are broken; the longest is 52 mm., and was probably well over 60 mm., but it was certainly not over 70 mm.; the colour is a light blackish-brown, with the arm-spines a much lighter yellow-brown; the under side of the arms shows the longitudinal white band on the first two or three segments distinctly, but further out it is much less evident; the specimen is probably somewhat bleached. The other large specimens are all darker, the colour ranging from brown to black, the arm-spines lighter than the disk, especially at their tips; in some cases they are reddish, and in one specimen very conspicuously so on distal part of arms. The

longitudinal white band on the under side of the arms is a characteristic feature, usually conspicuous at least at the base of the arms; in the blackest specimen it is well marked on the first five or six segments, and then fades away and becomes very indistinct. In no specimen is there any indication of banding on the arm-spines.

### OPHIOCOMA CANALICULATA var. PULCHRA ([39]) var. nov.

There are half a dozen *Ophiocomas* which agree well with *O. canaliculata* in everything but colour, and their striking appearance warrants designating them by a varietal name. As they probably intergrade with the typical form, and seem to occur with it, it is not likely they represent a different species. The two constantly characteristic features are found on the arm-spines and the

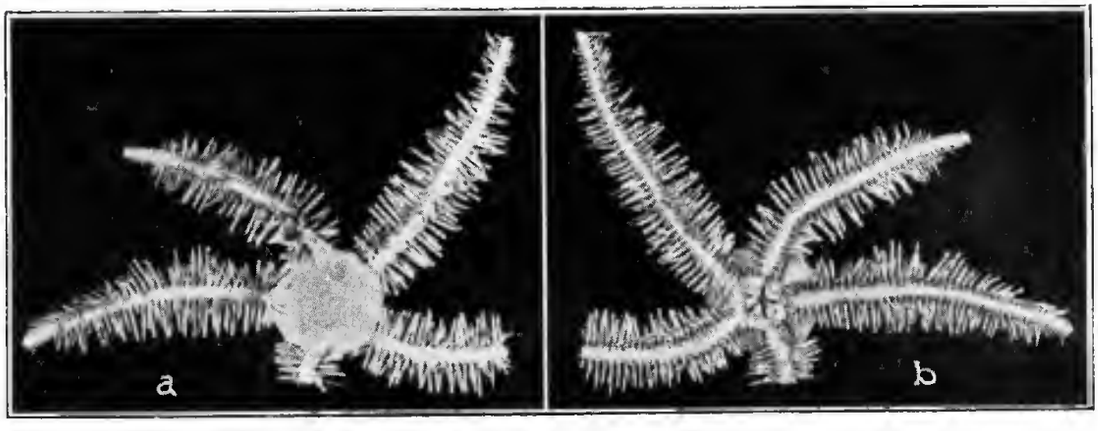


Fig 131. *Ophiocoma canaliculata* var. *pulchra;* a, aboral view; b, oral view of holotype (nat. size).

under arm-plates. The arm-spines are beautifully banded with light and dark; the exact shades differ in the different specimens; the ground colour ranges from nearly white to pale brown; the darker bands range from light brown, light red, or light greenish-brown to brown, red, and grey; the bands are narrow, well defined, especially at tips of spine, and numerous (five to ten). The under arm-plates, instead of showing a white median band, are, even from the first, prettily mottled with purplish-brown, bright brown, or grey and whitish or very pale brownish. The colour of the disk and upper surface of the arms shows considerable diversity; in typical specimens it is very light, almost white, the upper armplates being ornamentally marked with some light shade of brown or grey. In other specimens the disk is darker, and in one specimen it is the same shade of brown shown by small specimens of typical *O. canaliculata.* But

([39]) *Pulcher*=beautiful, in reference to the ornamental colour pattern of the arm-spines.

regardless of the disk, the arm-spines and under arm-plates are absolutely distinctive.

Holotype: Reg. No. E. 470.

The specimens at hand range from 7·5 mm. to 18 mm. across the disk. The two largest have no locality label, but the others are all from Dr. Verco's collecting in Spencer or St. Vincent Gulf.

## FAMILY OPHIODERMATIDAE.

### OPHIURODON Matsumoto.

### OPHIURODON OPACUM ([40]) sp. nov.

Disk 7·5 mm. in diameter; arms all broken, but no doubt more than 20 mm. long. Disk completely covered by a coat of fine but well-spaced spherical granules, about 150 to a square millimetre; these are somewhat coarser near the margin of the disk than at the centre; the coat of granules completely covers an underlying layer of rather delicate scales. Upper arm-plates, except for one or two at base of arm, longer than wide, at first broadly in contact, but becoming less and less so distally, until near tip of arm they are small and quite separate; distal margins curved, broadly so at base of arm, but becoming more and more semicircular distally; the plates are thick, dull, and without striations or other ornamentation.

Interbrachial areas below, oral shields, adoral and oral plates completely covered with a fine granulation like that of the disk, but coarsest on the jaws; the tips of the mouth angles are occupied by a group of six to nine granules, somewhat set apart from the rest, and occupying the space between the two lines of oral papillae. Oral papillae four on each side, placed somewhat on edge and overlapping, excepting the outermost, which is the smallest and least flattened; the other three are subequal, distinctly flattened, with rounded margin. Teeth very conspicuous, wide, with hyaline margin; there are apparently four in each column, but the lowest (outermost) is very short and broad, with an insignificant margin, while the next has a very conspicuous more or less serrate margin; in the holotype the median serrations are enough more conspicuous than the others to give the appearance of a triserrate tooth, but in the paratype this is not the case.

First under arm-plate small, wider than long, the second much larger, about as long as wide; succeeding plates becoming more and more evidently longer than wide, broadly in contact at first, but becoming less and less so, until

([40]) *Opacus*=in the shade, obscure, in reference to the uncertainty as to the relationships.

at the tip of the arm they are well separated; the distal margin is markedly rounded, the proximal is narrower and truncate or (distally) pointed, and the lateral margins are more or less concave. Side arm-plates rather large proportionately, especially distally; each plate carries six or, on basal segments of arm, seven, opaque, solid but delicate, blunt, somewhat flattened arm-spines, about as long as the segment or a trifle longer; they show a tendency to lie appressed to the arm, but obviously are not normally so in life; the upper ones (except uppermost, which may be quite small) are longest, and are somewhat widened near but not at the tip. Tentacle-scales two, large, the inner the larger and more elliptical; the outer overlies the base of the lowest arm-spine, and distally tends to be quite pointed. On the first pore there are five scales, two of which guard the distal side; on the second pore are four scales, of which one is on the distal side; on the third pore are three proximal scales, but the distal scale is reduced or wanting; on the following pores a distal scale may be more or less indicated for several segments.


Fig. 132. *Ophiurodon opacum;* a, aboral view; b. oral view of holotype (x 2).

Colour of holotype very pale grey, the disk mottled with a darker shade; arms with five or six darker bands at irregular intervals; these bands are more than one segment wide, and the outer portion is darkest; lower surface nearly white. Paratype very pale brown or dirty-whitish, without any indications of bands on arms or of mottling on disk.

Holotype: Reg. No. E. 471.

There are only two specimens of this interesting brittle-star, one from Port Vincent, the other (holotype) being from the Vereo collections from St. Vincent Gulf. The paratype is not quite 7 mm. across the disk, and the arms are about 23 mm. long; the arms are thus longer relatively than in the holotype, the arm-spines are a trifle longer and narrower, and the teeth are a trifle narrow and less evidently triserrate. This Australian *Ophiurodon* differs from the other members of the genus in the presence of two tentacle-scales and in the dull, unstriated arm-plates; indeed, the matter of the tentacle-scales has made me

hesitate to put the species in *Ophiurodon*, but in view of the disk covering, mouth parts, and arm-plates and spines, it seems unnecessary to erect a new genus for it, especially as *Ophiurodon* is itself so imperfectly known and its relationships so uncertain.

## PECTINURA Forbes.

### PECTINURA ARENOSA.

Lyman, Bull. M.C.Z., vi, 1879, p. 48.

There are nineteen specimens of this species from Tumby Bay; Ardrossan, Yorke Peninsula; between Trowbridge Lighthouse and Backstairs Passage; and the Verco collections in Spencer and St. Vincent Gulfs. They are all adults, with the disk 7 mm. to 11 mm. across; the arms are 3·5 to 4 times the diameter of the disk. There are eight or rarely nine arm-spines on the basal part of the arm of the smallest example, and ten or eleven in the case of the largest. A number of the specimens are uniformly very pale brown (or dirty cream-colour), without markings of any sort, but it is, of course, possible that these individuals have been more or less bleached in preservation. In other cases the disk is unicolour, brown, or grey of some shade, but the arms are more or less cross-banded, either light with dark bands or dark with light ones. The largest specimen has the disk dark grey mottled with light grey, and the arms dark with light bands, but the light and dark bands are of about equal width; oral surface of body nearly white, of arms mostly dull greyish-purple, with much less marked banding than on the upper surface.

### PECTINURA ASSIMILIS.

*Ophiopeza assimilis* Bell, Proc. Zool. Soc., 1888, p. 282.
*Pectinura assimilis* H. L. Clark, Bull. M.C.Z., liii, 1909, p. 118.

There are fifteen specimens of this species from Tumby Bay and from the Verco collections in Spencer and St. Vincent Gulfs. Although obviously different from the preceding species, no one character will serve to constantly distinguish them. The present species is decidedly the larger (with disks up to 21 mm. in diameter), with stouter but not shorter arms; in specimens of the same size the arm-spines are fewer in *P. assimilis* than in *P. arenosa*, but in large specimens there are eleven and even twelve arm-spines; the spines are longer in *P. assimilis*, nearly equalling the segment, while in *P. arenosa* they are only about half as long as the segment; the upper arm-plates in *P. arenosa* have a markedly curved (convex) distal margin, while in *P. assimilis* the plates are shorter and wider, with a nearly straight distal margin; in *P. assimilis* the penultimate oral papilla in each series is conspicuously the largest, but in *P. arenosa* this is not noticeable; finally, and most obvious if not most important,

in *P. arenosa* supplementary oral shields are usually present distal to the oral shields, but in *P. assimilis* these are usually wanting. In one large *P. assimilis* in the present series, supplementary shields are present in every interradius, but they are wide and low, closely appressed to the oral shield, and four of the five are divided, three into two and one into three pieces.

In colour the two species must be quite unlike in life, for the best specimens of *P. assimilis* show a distinct rose-purple colour in markings on disk or arms, or at least on the oral shields and basal under arm-plates. The most highly coloured specimen is pale yellowish-brown, with the centre of the disk and about five indefinite bands on each arm, rose-purple; orally the general tint is dull cream-colour, but the interbrachial areas, oral shields, and basal under arm-plates show more or less evident markings of rose-purple. At the other extreme is a nearly white specimen, with disk 16 mm. across, and arms about 60 mm. long, which shows no markings on the upper surface, but is very evidently rose-purple on the oral shields and basal under arm-plates; it is impossible to say whether this specimen has been bleached or not, but it does not give that impression. On the other hand, the only specimen with no trace of rose-purple is a large one (disk, 21 mm.), with lower surface cream-colour and upper surface dull light grey and yellowish intermingled with little contrast; this specimen has probably had its colours altered by exposure to light and dust.

In my key to the species of *Pectinura* ([41]) I have said of *P. assimilis:* "arms not at all spotted or marked with purple. Arm-spines sub-equal; oral shields rather wider than long." Evidently this is wrong in the matter of the colour, and it is also unreliable as regards the oral shields, for sometimes the oral shields, in small specimens, are longer than wide. The differences between *P. assimilis* and *P. maculata* of New Zealand are, however, very evident, for *P. maculata* has the arms more than four times the disk diameter, and the upper arm-plates are conspicuously spotted with purple; in *P. assimilis* the rose-purple is more like a ground tint irregularly mottled with the lighter shade. If the single specimen of *P. assimilis*, long in the M.C.Z. collection, and said to be from South Australia, has not had its colours artificially altered in some way, the species shows considerable diversity, for there is no trace of rose-purple anywhere, but that colour is replaced by a bright brown, in contrast with the very pale yellowish-brown ground colour.

## OPHIARACHNELLA Ljungman.

### OPHIARACHNELLA GORGONIA.

*Ophiarachna gorgonia* Müller & Troschel, Sys. Ast., 1842, p. 105.
*Ophiarachnella gorgonia* H. L. Clark, Bull. M.C.Z., lii, 1909, p. 123.

([41]) H. L. Clark, Bull. M.C.Z., lii, 1909, p. 116.

There are two dry, bleached specimens labelled "N. Australian Coast"; as the species is common there, there is no reason to doubt the label. One specimen, 8 mm. across the disk, still shows plainly half a dozen light brown bands on each arm. The other is 11 mm. in disk diameter, and the cross bands on the arms are very faint.

## OPHIARACHNELLA INFERNALIS.

*Ophiarachna infernalis* Müller & Troschel, Sys. Ast., 1842, p. 105.
*Ophiarachnella infernalis* H. L. Clark, Bull. M.C.Z., lii, 1909, p. 124.

This is another tropical species, of which three typical specimens, 9 mm. to 12 mm. across the disk, are in the present collection, from "N. Australian Coast." Their naturally dull colours have undergone little change.

## OPHIARACHNELLA RAMSAYI.

*Pectinura ramsayi* Bell, Proc. Zool. Soc., 1888, p. 281.
*Ophiarachnella ramsayi* H. L. Clark, Mem. M.C.Z., xxv, 1915, p. 305.

One of the four specimens of this species (which was first described from Port Jackson) was taken by Dr. Verco. It is from either Spencer or St. Vincent Gulf, and, although dry, is well preserved; the colour is cream-colour and pale grey irregularly and indefinitely mixed, with three or four dark grey bands on upper surface of each arm, and many dark grey spots both on disk and arms; under surface pale cream-colour; it is probable that these colours are more or less faded; the disk is 23 mm. across, and there are eleven arm-spines on the basal segments.

The other specimens are obviously old and somewhat deteriorated. One with the label: "Presented by Rumball, Esq., Queenscliff, Kangaroo Island, December, 1901," has the disk 30 mm. across and the arms 150 mm. long; there are thirteen arm-spines on some basal segments; the colour is a variegation of light and dark yellow-brown, with many dark spots or dots on the lighter areas, and the arms more or less conspicuously banded. The other two specimens are labelled, "Presented by J. G. McDougall, Esq., Edithburgh, December, 1887." One has only four arms, as one has been broken off close to the disk, which is 29 mm. across; the point where the arm was lost has apparently healed, but there is no indication of regeneration; there are thirteen arm-spines. The other has the disk 32 mm. across, but the arms are only 125 mm. long; there are thirteen, rarely fourteen, arm-spines. The colour of these Edithburgh specimens is essentially the same as in the individual from Kangaroo Island, but the arms are less distinctly banded.

## Family OPHIOLEPIDIDAE.

### AMPHIOPHIURA Matsumoto.

### AMPHIOPHIURA COLLETA.

H. L. Clark, "Endeavour" Res., iv, 1916, p. 93.

It is interesting to find this species in the collection, but most disappointing to find only one specimen, and that but half-grown. This individual was taken by Dr. Verco in either Spencer or St. Vincent Gulf. The disk is 8 mm. across, and the arms were about 24 mm. long, as far as can be estimated, since all are broken. In the arrangement of disk-plates and arm-spines this specimen is like the holotype, but the upper and under arm-plates reveal its immaturity, since very few proximal plates are wider than long and fully in contact. The oral papillae too are immature, and not so distinctive as in the original specimen. The colour is not at all yellowish, but is greyish-white.

### OPHIURA Lamarck.

### OPHIURA KINBERGI.

Ljungman, Ofv. Kongl. Vet.-akad. Föhr., xxiii, 1866, p. 166.

This brittle-star was previously known from Port Jackson and Port Phillip, but its occurrence in the Verco collections from Spencer and St. Vincent Gulfs is a considerable extension of its range westward. There are seven specimens at hand, ranging in disk diameter from 5 mm. to 9 mm.; the arms are slender but short; it is doubtful if they ever exceed three times the disk diameter.

### OPHIURA OOPLAX.

*Ophiocten oöplax* H. L. Clark, Bull. U.S. Nat. Mus., lxxv, 1911, p. 99.
*Ophiura oöplax* Matsumoto, Proc. Acad. Nat. Sci. Philadelphia, lxvii, 1915, p. 81.

The discovery of this Japanese species in the Verco collections from Spencer and St. Vincent Gulfs is most surprising. It is so well marked a species that there is no danger of mistaken identification, nor can I find any notable differences between Japanese and South Australian specimens. There are nine specimens in the Verco collection, and they range from 4 mm. to 8·5 mm. across the disk; the colour is uniform, grey or nearly white. In Japanese waters this brittle-star is common at depths of 94 fathoms to 614 fathoms, and has not been taken in shallower water. It would be very interesting to know at what depths the South Australian specimens were taken. No records of *O. oöplax* between Japan and South Australia exist.

## OPHIOMUSIUM Lyman.

### OPHIOMUSIUM ANISACANTHUM ([42]) sp. nov.

Disk 13 mm., arms broken, but apparently about 50 mm. long. Disk covered with a very smooth coat of closely appressed plates; at first there are a central plate, five radials, ten radial shields, ten plates in pairs, smaller proximal to larger, both long and narrow, lying in the interradii, separating the pairs of radial shields from each other, and ten plates in pairs, the distal much the smaller, lying in the radii, and separating the two radial shields of each pair; thirty-six plates in all; but with growth smaller plates come in at the angles where the larger plates meet each other, until 75 to 90 scales and plates may be counted on the disk of a full-grown specimen. Radial shields moderate, not much longer than wide, roughly rounded triangular, fully separated from each other both radially and interradially. All disk plates are apparently quite smooth, but under sufficient magnification are found to be very finely granular. Upper arm-plates present only basally; the first is large, pentagonal, almost twice as wide as long; the second is very much smaller, wider than long, triangular with the angle proximal; succeeding plates similar but smaller, and decreasing steadily in size from segment to segment, disappearing entirely at the tenth segment (or thereabouts) in large specimens, nearer to disk in smaller ones.

Interbrachial areas below completely covered by one huge marginal plate, the two genital plates, and the oral shield; the marginal plate is about twice as wide as long. Oral shields somewhat pentagonal, with distal side longest and perfectly straight; outer lateral margins about one-half of distal, very slightly convex; inner lateral margins slightly concave distally, a trifle convex proximally, meeting in a sharp angle. Adoral plates very large, nearly three times as long as wide, meeting fully within, wider without than within. Oral plates smaller than adorals; each carries four subequal squarish oral papillae, while a fifth one, considerably larger, is half on the oral and half on the adoral plate; at the tip of the jaw is a large unpaired, somewhat triangular papilla.

Under arm-plates, except first three, insignificant, triangular, wider than long, practically wanting after the first six or eight segments; second and third are practically the same shape as the oral shields, but are longer than wide, the second being relatively longer than the third; first under arm-plate not half as large as second, slightly hexagonal, a little wider than long, with proximal angle much larger and more acute than distal. Side arm-plates very large, composing practically the whole segment; each plate carries near the lower distal corner, but well back from the margin of plate, two arm-spines, placed close together,

([42]) *ἄνισος*=unequal+*ἄκανθα*=spine, in reference to the striking inequality of the arm-spines.

the lower cylindrical, blunt, almost half as long as a basal arm-joint; upper, peg-like, minute, not half as long as lower; on basal joints, a third, even smaller peg-like spine may be found near margin, well up on the plate, and occasionally a fourth, still smaller, is present between the lower pair and the upper single spine. Tentacle-pores in two pairs, beside second and third lower arm-plates, with a long, narrow, elliptical scale on the outer side, and a very much narrower and less noticeable one on the inner side. Colour, nearly white.

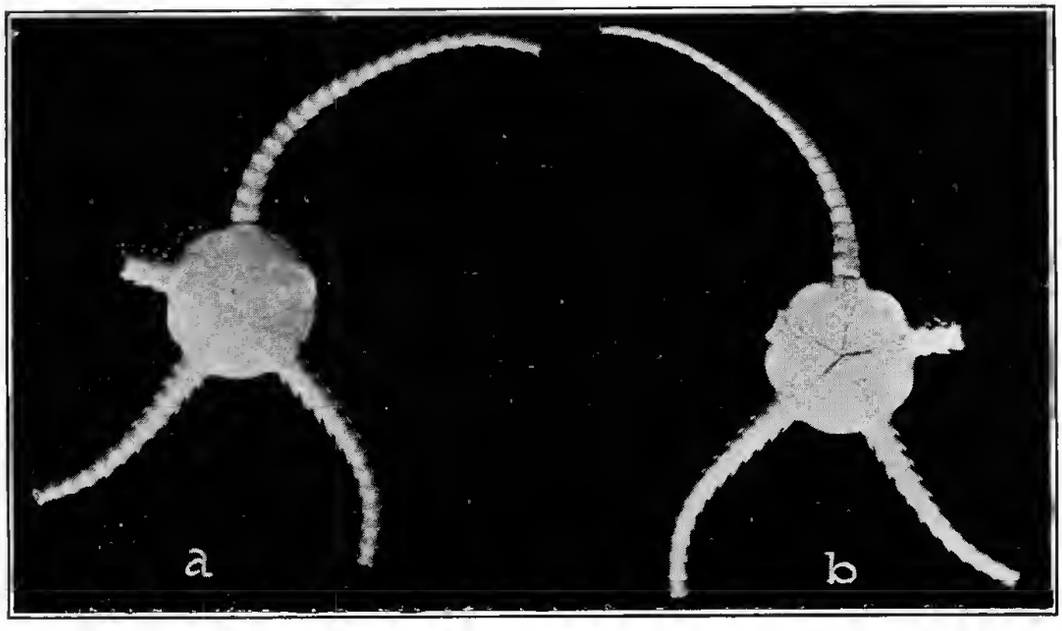


Fig. 133. *Ophiomusium anisacanthum;* a, aboral view; b, oral view of holotype (nat. size).

Holotype: Reg. No. E. 480.

There are five specimens of this well-marked species in the Verco collections from Spencer and St. Vincent Gulfs. The smallest is somewhat more than 9 mm. across the disk, while the arms (broken now) could not have much exceeded 30 mm. The species may be recognized at once among those with only two pairs of tentacle-pores by the combination of a single huge interbrachial plate orally, with only one arm-spine large and well developed enough to be called a spine.

### OPHIOMUSIUM APORUM (43) sp. nov.

Disk 9 mm. in diameter; arms about 30 mm. long. Disk covered by about thirty-one large plates, including the radial shields, and many, small, triangular, ill-defined plates at their angles; all the plates are covered by a thick, wrinkled skin, but it looks as though the skin on each plate had dried and wrinkled by

(43) ἄπορος=without a pore, in reference to the apparent absence of tentacle pores.

itself. Radial shields small, separated. Upper arm-plates ten to twelve, but only the first two are worthy of mention; they are small, triangular, about as long as wide, the first the larger.

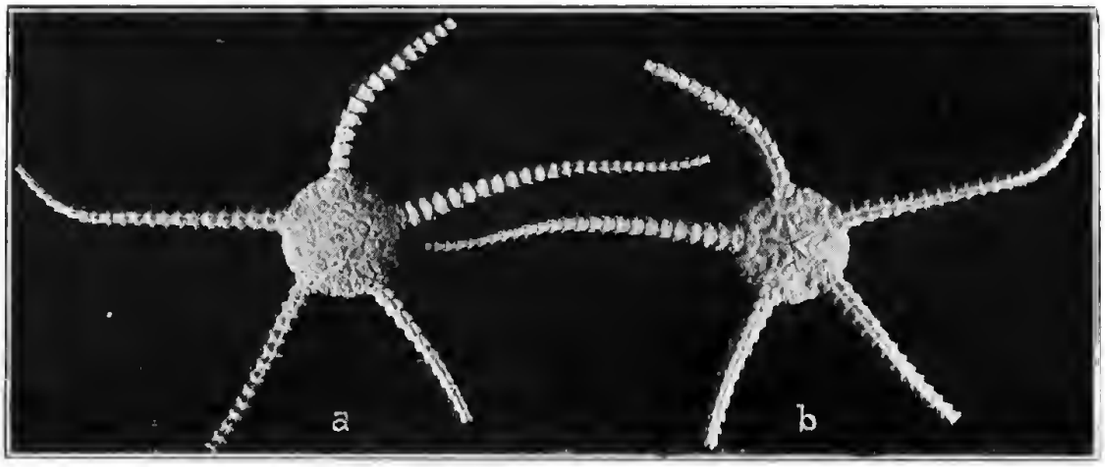


Fig. 134. *Ophiomusium aporum*; a, aboral view; b, oral view of holotype (x 2).

Interbrachial areas below covered by a large median and two smaller marginal plates, the two genital plates, and the oral shield; these plates are like those of the disk in appearing as though each were covered by wrinkled skin. Oral shields rounded pentagonal, with an angle proximally, about as long as wide. Adoral plates relatively large, short, and wide, meeting broadly within. Oral plates small and indistinct. Oral papillae apparently four or five, but difficult to distinguish separately, as they are more or less concealed in skin. First under arm-plate small, nearly square, second and third somewhat larger, roughly triangular; no under arm-plates present further out. Side arm-plates large, somewhat flaring distally; each carries three subequal, small, peg-like arm-spines not one-third as long as arm-segment; those near base of arm are more blunt and peg-like than distally, where they are quite acute. Tentacle-pores very difficult to make out, but present beside second under arm-plate, and probably also beside third; tentacle scales small, elliptical, difficult to make out on most pores. Colour pale greyish, nearly white.

Holotype: Reg. No. E. 481.

There are but two individuals of this curious species in the collection, both having been taken by Dr. Verco in Spencer and St. Vincent Gulfs. The paratype is obviously young, and shows some notable peculiarities. The disk is only 4 mm. in diameter, and the arms could hardly have exceeded twice that. There seem to be neither upper nor under arm-plates, and as a rule only one or two arm-spines are to be found on a side arm-plate. All over the plates of the disk

and those of the interbraehial areas below are minute, pointed granules; apparently these are worn down with growth, and more or less wholly disappear. There is no traee of tentacle-pores. It is not likely that this species will be confused with any other in the genus, as the apparent absence of tentacle-pores is quite unique.

### OPHIOMUSIUM SIMPLEX var. AUSTRALE, var. nov.

Disk 14 mm. in diameter; arms probably about 50 mm. long. Differs from typical adult *O. simplex* (*O. sanctum* Koehler) in having more numerous, rounder, flatter disk plates, less swollen marginal plates, and fewer interbrachial plates orally. There is but a single specimen, and it is possible that it is only an

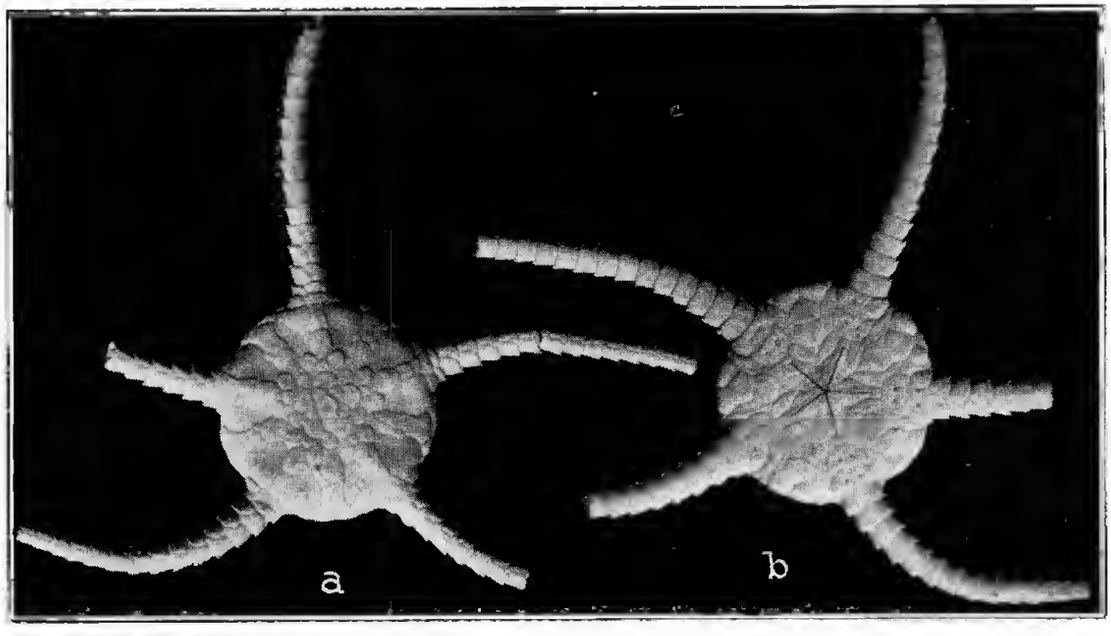


Fig. 135. *Ophiomusium simplex* var. *australe;* a, aboral view; b. oral view of holotype (x 2).

individual variant, but as it was taken by Dr. Vereo in either Spencer or St. Vineent Gulf, while the typical form is known only from the East Indian region, it seems best to regard it as a southern variety until sufficient material is accumulated to determine its status accurately. Reg. No. E. 482.

### OPHIOZONELLA Matsumoto.

### OPHIOZONELLA ELEVATA.

*Ophiozona elevata* H. L. Clark, Bull. U.S. Nat. Mus., lxxv, 1911, p. 31.
*Ophiozonella elevata* Matsumoto, Proc. Acad. Nat. Sci. Philadelphia, lxvii, 1915, p. 82.

It seems very extraordinary that this Japanese species should occur in South Australian waters, but there are two specimens, taken by Dr. Verco, in the present collection. They came from either Spencer or St. Vincent Gulf. They agree with a Japanese paratype of *O. elevata* in all essentials, except that the arm-spines are longer and the upper arm-plates are more fully in contact and have a more convex distal margin. The length of the arm-spines is striking, as the upper one is nearly as long as two joints, but I cannot refer these specimens to *O. bispinosa* Koehler, as would seem natural, the difference in the upper arm-plates is so great. Koehler ([44]) thinks the shape of the oral shields may be an aid in distinguishing *O. elevata* and *O. bispinosa*, but I find enough diversity in *O. elevata*, where the shields may be longer than wide, as in *O. bispinosa*, to convince me this feature will not help us. Should further material show that *O. bispinosa* and *O. elevata* do not have the marked difference in upper arm-plates which Koehler's figures and description lead me to suppose, then *O. elevata* becomes a synonym of *O. bispinosa*, and both the Japanese and South Australian specimens must be referred to Koehler's species.

## OPHIOCROSSOTA ([45]), gen. nov.

Disk covered with large smooth plates and scales, very regularly arranged and with primary plates conspicuous. Radial shields broadly in contact proximally but separated distally by a large triangular plate; outer margin of this plate and inner margin of distal half of radial shields provided with minute, crowded but distinct papillae, in a single series; the series on the radial shield is virtually (but not actually) continuous with the series of similar but larger papillae on the adradial margin of the genital plates. Upper arm-plates wider than long on basal part of arm and broadly in contact there. Oral shields very large occupying most of interbrachial areas below. Second pair of oral papillae opening outside of mouth slits guarded by tentacles scales on both sides. Under arm-plates somewhat swollen, separated from each other, on basal part of arm by a distinct pit. Arm spines numerous. Tentacle-pores very large, protected by a tentacle-scale and the lowest arm-spine, which are virtually side by side.

Genotype: *Ophiocrossota heteracantha* sp. nov.

This is a very remarkable genus, showing a combination of characters quite unique. The papillae on the radial shields suggest at once the West Indian genus *Ophiothyreus*, but in that case the radial shields are wholly separated, and distally by a pair of plates, lying side by side. Orally the

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([44]) Koehler, Bull. U.S. Nat. Mus., 100, v, 1922, p. 422.

([45]) ὄφις=snake+ κροσσωτὸς=fringed, in reference to the papillae on the radial shield margin.

Australian genus is utterly unlike *Ophiothyreus*, but reminds one very much of *Stegophiura*, from which, however, the character of the tentacle-pores instantly separates it.

### OPHIOCROSSOTA HETERACANTHA ([46]) sp. nov.

Disk 11 mm. in diameter; arms broken, but probably about 40 mm. long, broad and stout at base, but tapering rapidly to a very slender tip (as shown by other specimens). Disk covered by twenty-six large, smooth plates, besides many small ones at their corners, the radial shields and five large marginal plates, one in each interradius. Radial shields large, nearly twice as long as wide, meeting broadly within, separated distally by a large triangular plate;

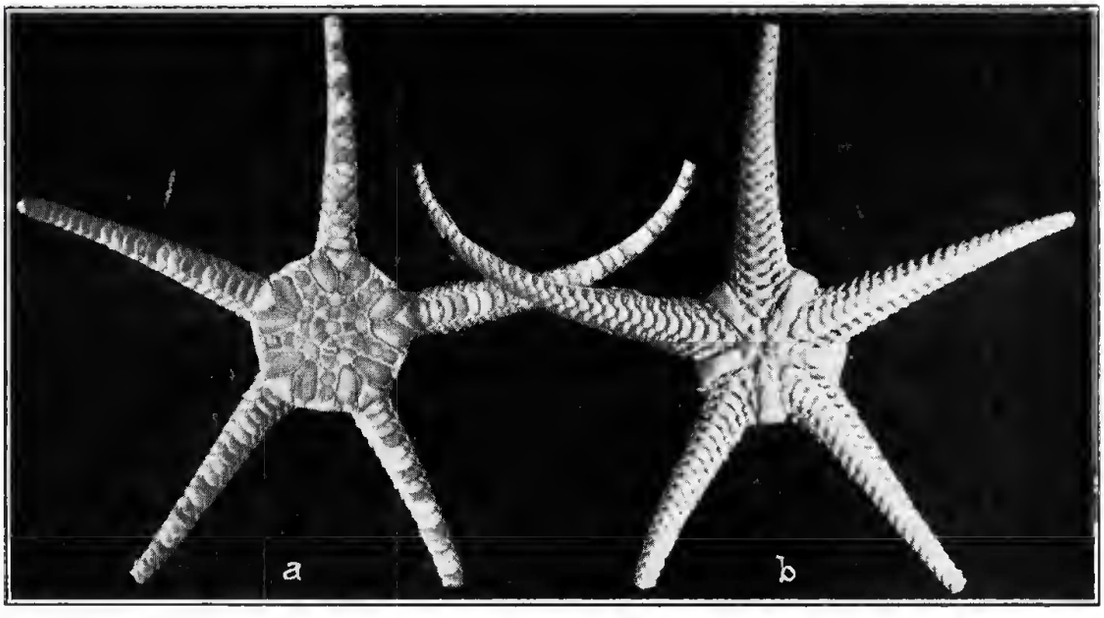


Fig. 136. *Ophiocrossota heteracantha;* a, aboral view; b, oral view of holotype (x 2).

on the margins of this plate and the distal inner margin of the radial shields are the fringes of minute papillae so distinctive of the genus. Upper arm-plates broadly in contact proximally, but distally they become small, triangular, and separated; first one very short and wide, as wide as the triangular plate that separates the radial shields, its length about one-fifth of its width; second plate not so wide, but twice as wide as long, with convex distal margin and moderate lateral angles; succeeding plates becoming more and more triangular, narrower, longer, but smaller.

Interbrachial areas below almost covered by the huge oral shields, which are more than twice as long as broad, sharply pointed proximally, but rounded

([46]) ἕτερος=different+ ἄκανθα=spine, in reference to the dissimilar arm-spines.

distally; besides the shield, the only plates in the interbrachial areas are the broad genitals, the conspicuous marginal, and two or three small plates just distal to the oral shield; genital plates with a conspicuous fringe of ten to twelve papillae, the lower ones rather long, the uppermost much like those on the adjoining radial shields. Adoral plates rather small, but swollen, meeting broadly within. Oral plates conspicuous, swollen, larger than the adorals. Oral papillae small, about four on each side of each jaw, the distalmost largest, low, flat, and scale-like. Teeth about three, or possibly four, in a column, narrow, pointed.

First under arm-plate large, tetragonal, about as long as wide, but wider distally than proximally; second plate pentagonal with a sharp proximal angle, and rounded lateral margins and angles, much wider than long, somewhat swollen, separated from first plate by a large pit, and from third plate by a smaller one; next three plates similar but successively smaller; following plates about as long as wide, widely separated from each other, not swollen, and not separated by pits, becoming very small and nearly circular distally. Side arm-plates not very large, but thick at the oral end, not flaring; each carries a series of twelve or fewer spines, of diverse sizes; the third from the bottom is largest, cylindrical, blunt, about half as long as arm-segment; the uppermost and the lowest come next, and are about three-fourths as large; the next to lowest and the one above the largest are next in order, while the others passing from below up become successively smaller, the next to uppermost being smallest and hardly a quarter the size of the uppermost. First tentacle-pore (second oral) opens outside mouth-slit, and is protected by two low, broad, flat scales on each side; succeeding pores very large, with a single, thick, rounded scale on the side arm-plate, and on the first two or three pores a minute scale in the angle where the distal margin of the under arm-plate touches the side arm-plate; the lowest arm-spine stands beside the tentacle-scale, and it and the one above it apparently function as tentacle-scales. Colour pale brown or nearly white, with radial shields and sometimes the central plates a distinctly darker shade; groups of from one to four upper arm-plates are also a darker brown, so that the arms appear banded; lower surface uniformly white, whitish, or pale brown; the variegated upper surface is more or less strikingly ornamental.

Holotype: Reg. No. E. 484.

This is a pretty and interesting brittle-star, apparently common in St. Vincent and Spencer Gulfs, where fifty-three specimens were collected by Dr. Verco. It is remarkable that so striking a form should have so long gone undescribed. It cannot possibly be confused with any other Australian brittle-star, and, indeed, there is nothing like it to be found elsewhere. It is unfor-

tunate that we do not know at what depth it occurs; it does not look like a deep-water form.

### OPHIOLEPIS Müller & Troschel.

### OPHIOLEPIS SUPERBA.

*Ophiura annulosa* Blainville, 1834, *not* Lamarck, 1816.
*Ophiolepis superba* H. L. Clark, Spolia Zeylanica, x, 1915, p. 89.

There are twenty adult specimens in the collection, all dry. There are no locality labels for fourteen, but six are said to be from "Spencer Gulf." This is almost certainly a mistake, as the species is a strictly tropical one. Probably all the specimens are from the coast of the Northern Territory. The smallest is 15 mm. across the disk, and the arms are rather more than 40 mm., while the largest has the disk diameter 25 mm., and the arms exceed 80 mm.

### OPHIOPLOCUS Lyman.

### OPHIOPLOCUS IMBRICATUS.

*Ophiolepis imbricata* Müller & Troschel, Syst. Ast., 1842, p. 93.
*Ophioplocus imbricatus* Lyman, Proc. Boston Soc. Nat. Hist., viii, 1861, p. 76.

There are four specimens of this easily recognized species, but they have no locality label. There is little doubt, however, that they are from the coast of the Northern Territory, as it is highly improbable that the species occurs on the southern coast of Australia. The present specimens measure from 11 mm. to 16 mm. across the disk.

## ECHINOIDEA

There are 1,519 sea-urchins in the collection, representing forty-six species and two varieties, but seventeen specimens, representing the following ten well-known species, are non-Australian in origin:

*Psammechinus microtuberculatus* (Blainville)
*Echinus esculentus* L.
*Paracentrotus lividus* (Lam'k.)
*Evechinus chloroticus* (Val.)
*Strongylocentrotus purpuratus* (Stimp.)
*Heterocentrotus trigonarius* (Lam'k.)
*Arachnoides zelandiae* (Gray)
*Dendraster excentricus* (Esch.)
*Mellita quinquiesperforata* (Leske)
*Brissus latecarinatus* (Leske)

No further reference will be made to these species.

Of the remaining thirty-eight forms, six species are described as new, and one of these represents an extraordinary new genus in the family Arachnoididae, which has hitherto contained but a single genus. This new form looks, at first glance, like a scutellid, and particularly like the common sand-dollar *(Echinarachnius)*, but more careful examination shows that it is really quite close to *Arachnoides*. There are two species, *Phyllacanthus irregularis* and *Apatopygus recens*, which are here recorded from Australia for the first time.

Only twenty-five of the thirty-eight forms are certainly from the southern coast of the continent, while three are from the western and ten from the northern or north-eastern coasts. One of the west coast species is known from the southern coasts and Tasmania, while the other two are extremely rare forms, whose presence in this collection is particularly noteworthy; one *(Apatopygus recens)* is a New Zealand species of a monotypic genus, and the other *(Goniamorelia interrupta)* has been known hitherto only from the unique holotype in the Berlin Museum, which came from Western Australia; unfortunately the present specimen has no locality label. The ten northern or north-eastern species are well-known tropical forms, though one *Arachnoides placenta*, has a peculiar distribution, the limits of which are not yet well marked out.

More than two-fifths of the specimens belong to three species of the family Fibulariidae, while nearly half the remainder are Temnopleurids. There are ten species, which have 1,294 specimens, or an average of almost 130 for each, while on the other hand there are thirteen species represented by only one specimen each, and two of these are hitherto undescribed species.

Horizontal diameter is abbreviated to "h.d." in the following pages, while "v.d." refers to the vertical diameter.

## ORDER CIDAROIDA

### FAMILY CIDARIDAE.

#### PHYLLACANTHUS Brandt.

#### PHYLLACANTHUS IRREGULARIS.

Mortensen, Vid. Medd. Dansk. Naturhist. Forening, Copenhagen, lxxxv, 1928.

There are five large individuals of *Phyllacanthus* which Dr. Mortensen has examined and found to belong to his new species. Unfortunately they have no locality labels, so that it is impossible to say from what part of the Australian coastline they come. As no specimens of *Phyllacanthus* have been recorded from Australia south of Port Hacking, on the east, and Fremantle on the west, it seems

probable that the present specimens are from the coast of the Northern Territory. They range from 71 mm. to 101 mm. in diameter, and in four of the specimens the primary spines are less than 50 mm. long. In the fifth individual, however, they are nearly 60 mm. long, and are conspicuously more tapering and pointed than in the others; their surface is also smoother, the coarse granules having the appearance of being flattened or ground down by friction, and the whole spine more or less overlaid by a deposit of some sort. But as the primaries are rust-colour, and the whole animal is dull and orally quite rusty, there can be little doubt that some misfortune in preservation accounts for this colouration and for the appearance of the primaries.

The character of the secondary and miliary spines distinguish *P. irregularis* from *P. imperialis* or its variety *parvispinus* very easily, for they are pointed and narrow, and show great diversity of size, instead of being blunt, wide, and scale-like, as in the long-known forms. It is worthy of note also that *P. irregularis* has nine or ten coronal plates in a column in all these specimens, whereas *P. imperialis* and var. *parvispinus* very rarely indeed have more than seven, even in the largest individuals.

### PHYLLACANTHUS sp. ?

A defective, but large, bare test of a *Phyllacanthus*, which measures 80 mm. in diameter, has but seven coronal plates in a column. It is probably *P. parvispinus*, but may be *P. imperialis*. As it lacks distinctive characters as well as locality label, its identification must be left unmade.

### PRIONOCIDARIS A. Agassiz.

### PRIONOCIDARIS BISPINOSA.

*Cidarites bispinosa* Lamarck, Anim. s. Vert., iii, 1816, p. 57.
*Prionocidaris bispinosa* Döderlein, Abh. Senck. Nat. Ges., xxxiv, 1911, p. 240.

There are five specimens which I refer to this beautiful northern Australian species. There are no locality labels, but probably all came from the Northern Territory. The finest individual is 40 mm. in h.d., and has magnificent primaries, some of which are more than 90 mm. long. Of the five specimens, two are bare tests, 20 mm. and 37 mm. h.d., lacking their apical disks.

### GONIOCIDARIS Agassiz & Desor.

### GONIOCIDARIS GERANIOIDES var. TUBARIA.

*Cidarites tubaria* Lamarck, Anim. s. Vert., iii, 1816, p. 57.
*Goniocidaris geranioides* var. *tubaria* H. L. Clark, Cat. Rec. Ech. Brit. Mus., 1925, p. 31.

There is a notable series of this common sea-urchin, and it is interesting to find that all are of the variety *tubaria*; there is not a typical *G. geranioides* in the collection. The smallest specimen is 7 mm. in diameter, and has only five plates in each interambulacral column; the largest is 58 mm. h.d. and 38 mm. v.d., and has thirteen such plates. So far as I can ascertain, this is the largest specimen of either *G. geranioides* or its variety *tubaria* that has been recorded. Large specimens usually have ten or eleven plates in each column, but there is great diversity in the relative height of the test; a specimen 20 mm. in diameter is only 11 mm. high, another is 34 mm. by 18 mm., and another is 39 mm. by 20 mm.; on the other hand a specimen 41 mm. h.d. is 34 mm. high, and another 34 mm. h.d. is 31 mm. high; thus the relative height of the test runs from about ·53 to ·91 h.d. But the greatest diversity is found in the character of the primary spines; so extraordinary is this that one is tempted to find some sort of distinctive characters in these primaries. But I am convinced this is a vain quest, so abundant and so complete are the intergradations. It is not difficult to group the specimens roughly into those with relatively slender, unexpanded spines with few, small prickles or none; those with moderately stout or slender spines, with few or no prickles, but with the tips of some, at least, of the dorsal spines, conspicuously expanded into shield-like tips; and those with short, stout, and very prickly or coarsely thorny spines. Most of the specimens fall into the third section, but there are all sorts of mixtures of the various characters, so that none of the sections are well-defined. As a representative of the first section is a specimen 48 mm. h.d., in which the primary spines are 25 mm. to 30 mm. long, 2 mm. to 2·5 mm. in diameter, and little or not at all expanded at tip. A specimen of the second section is 25 mm. in diameter, the spines in the mid-zone are about 18 × 2·5 mm., with more or less conspicuous prickles, and the aboral spines are 7 mm. to 8 mm. long and about 5 mm. across the expanded tips. An individual 20 mm. in diameter is an extreme illustration of the third section, for its principal primary spines are about 16 mm. long, 6 mm. or more wide, and many of the thorns they bear are 2 mm. long. In many individuals with thorny spines these become the points of attachments for barnacles, worm-tubes, bryozoa, and sponges, which are frequently large enough or numerous enough to give the animal a curiously bizarre appearance.

The most interesting and valuable of all the specimens in the collection is the one which has already been mentioned as measuring 31 mm. high, although it is only 34 mm. in diameter. In addition to its exceptional height, this individual is almost perfectly tetramerous; only on the peristome is there any evidence of a fifth area. This curious specimen has been figured and fully described in a paper by Dr. Robert T. Jackson ([47]), dealing with non-pentamerous variants among echini.

([47]) Mem. Boston Soc. Nat. Hist., viii, 1927, pp. 507-509, figs. 48, 49, 49a.

Very few of the specimens have any locality label. There is one from Queenscliff, Kangaroo Island, and two young ones from off Cape Jaffa in 90 fathoms. From off Cape Marsden, in 17 fathoms, Dr. Verco collected four very young bare tests, and there are some additional specimens from Dr. Verco's collecting in Spencer and St. Vincent Gulfs. Finally, the remarkable tetramerous specimen and a somewhat larger but notably high individual are from "South Melbourne, Victoria, 1889. Presented by J. W. Syke, Esq."

## ORDER CENTRECHINOIDA

## SUB-ORDER STIRODONTA

### FAMILY STOMOPNEUSTIDAE.

#### STOMOPNEUSTES Agassiz.

#### STOMOPNEUSTES VARIOLARIS.

*Echinus variolaris* Lamarck, Anim. s. Vert., iii, 1816, p. 47.
*Stomopneustes variolaris* Agassiz, Mon. Ech. Anat. Echinus, 1841, p. x.

A single bare test, 80 mm. in diameter, pale drab in colour, is the only representative of this species. As there is no locality label, its origin is unknown, but the species occurs on both the eastern and northern coasts of Australia.

## SUB-ORDER CAMARODONTA

### FAMILY TEMNOPLEURIDAE.

#### GENOCIDARIS A. Agassiz.

#### GENOCIDARIS INCERTA ([48]) sp. nov.

Test 6 mm. h.d.; 3 mm. v.d.; the height of test runs from ·50 to ·60 h.d. Coronal plates, and ambulacral plates, each nine or ten in a column. Arcs of pores just enough curved so that the adradial margin of the poriferous area is not perfectly straight. Abactinal system about 3 mm. across; oculars all exsert, especially II, III, and IV; I is nearest insert. Periproctal plates wanting. Madreporic plate not enlarged (genital three is just as big) and madreporic pores few. Genital pores evident, but ocular pores more difficult to find. Ocular and genital plates rough, with a few, low, indistinct tubercles. Sculpturing of test visible only under high magnification, of little significance. Primary tubercles large, smooth, imperforate, several times larger than any

([48]) The poor condition of the material is the cause of uncertainty as to the status of this new form.

of the secondaries. Peristomal membrane and buccal plates wanting. Gill-slits barely indicated. Colour greenish and whitish or very pale yellow.

Holotype: Reg. No. E. 623.

There are sixty-three specimens of this little urchin at hand, ranging in size from less than 3 mm. to more than 8 mm. h.d. As only two have an oculogenital ring, and not one has the periproctal plates or the buccal membrane present, it is obvious that even the genus is uncertain. The reason for calling it *Genocidaris* is the very close resemblance to *G. maculata*, of the West Indies. It is so similar in form, tuberculation, and colour that it is only when specimens of the same size are examined critically side by side under a lens that the difference becomes clear. The Australian form has the sculpturing reduced to a minimum (one might very naturally call it wanting), the adradial margin of the poriferous areas is not so sharply cut as in *G. maculata*, and most obvious, the primary tubercles of *G. incerta* are very much larger both actually and relatively. Apparently the abactinal system is smaller in *G. incerta*, but this difference may not be constant, and certainly cannot be expressed in figures. Of course, it cannot be certain that the Australian form belongs in *Genocidaris* until specimens with periproctal plates and peristomal membrane are taken and studied.

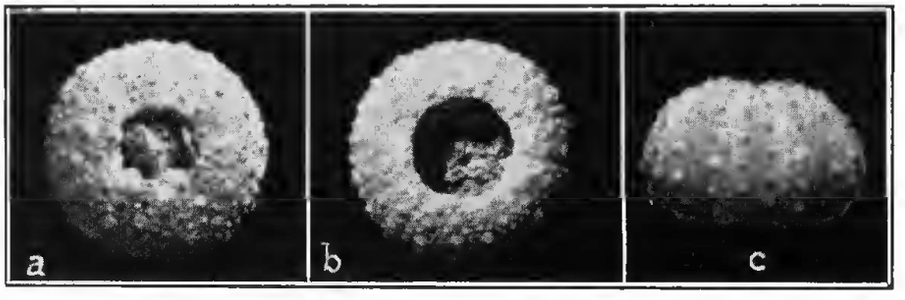


Fig. 137. *Genocidaris incerta;* a, aboral view of holotype (x 4); b, oral view, and c, side view of paratype (x 3).

All of the sixty-three specimens are bare tests, nearly all with no oculogenital ring. They were taken by Dr. Verco in his dredging at the following places: off Cape Borda, Kangaroo Island, 60 fathoms; off Cape Jaffa, 90 to 300 fathoms; off Beachport, 110 to 200 fathoms.

## TEMNOPLEURUS Agassiz.

### TEMNOPLEURUS AUSTRALIS [49] sp. nov.

Test 20 mm. h.d., 10·5 mm. v.d., rather flat, with ambitus circular, or rounded pentagonal in some large specimens, and peristome little or not at all

[49] *Australis*=southern, in reference to its being the southernmost species in the genus.

sunken. In some individuals the dorsal flattening is very marked, in others the abactinal surface is distinctly conical, though low. Coronal plates seventeen or eighteen in a column, with distinct but not large triangular pits at each of the lower corners, except in the case of the two or three uppermost and one or two of the lowest; above ambitus each plate carries near its centre a large, imperforate, non-crenulate, primary tubercle, one or two secondaries near its inner end, and two or three small secondaries near the outer margin; at ambitus and below, excepting only the lowest two plates, each plate carries a horizontal series of three primaries, above which is a well-spaced series of half a dozen small secondaries or miliaries. Ambulacral plates also seventeen or eighteen in a column, with relatively large pits at the inner lower corner (excepting only the oldest and youngest plates), smaller ones at the outer corners, and a very small pit half-way between each pair of larger ones; there are two or more small tubercles on each plate, especially below the ambitus. Poriferous areas nearly straight, but the middle pair of pores in each are is set out a little further from the mid-radius than are the other two; pores large, almost as large as the largest pits, set near together, the distance between them much less than diameter of a pore.

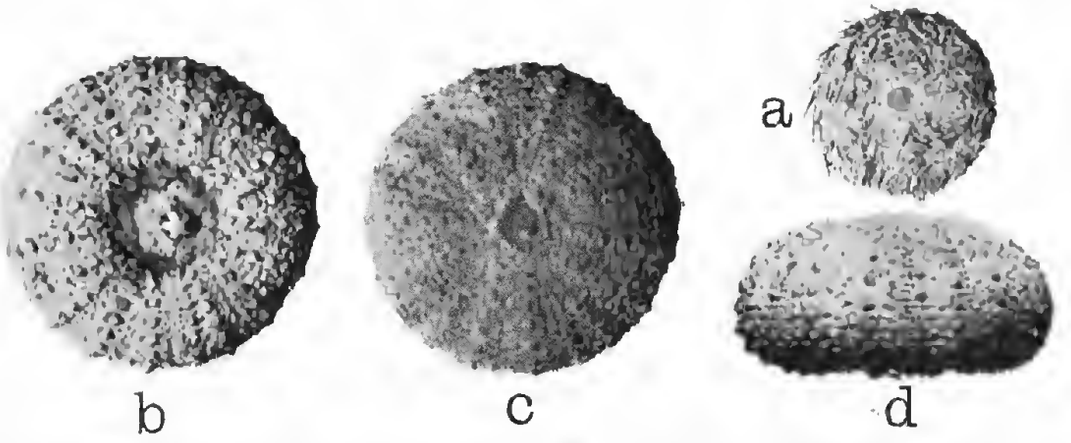


Fig. 138. *Temnopleurus australis;* a, aboral view of holotype (nat. size); b, aboral view, c, oral view, and d, side view of paratype (x 2).

Abactinal system large, about 6 mm. across; oculars all completely exsert; genitals with five secondary tubercles set side by side along the inner margin, and no other tubercles on the plates; madreporite conspicuous, but not larger than genital three; genital pores large, at centre of each plate; ocular pores small, horizontal slits, distal to centre of plate, overhung by a small swelling, back of which is a small secondary and a number of miliary tubercles. Periproct large, about 3 mm. across, covered by numerous small polygonal plates, among which a supranal can be easily distinguished; anus excentric near ocular I. Peristome

about 7 mm. across, with very shallow and insignificant gill-cuts; membrane thin and bare, save for the five pairs of very small buccal plates and a few minute, scattered plates proximal to them. Primary spines 3 mm. (dorsally) to 5 mm. (orally) long, slender, pointed. Pedicellariae of all four kinds present; the globiferous resemble very closely those of *T. reevesii*, while the tridentate are much like those of *T. tarentinus*; neither the ophicephalous or triphyllous show any distinctive features. Spicules seem to be very scarce; I found none in the heads of the globiferous pedicellariae which I examined, and only a few in the tube-feet; all that were seen were hihamate. Colour of test grey, a darker shade usually somewhat variegated with a paler one; often there is a more or less evident green tinge, especially on the periproct; primary spines dull red-violet or purplish-red, more or less markedly green-tipped, and in long spines the green may fade into whitish at the extreme tip; secondary spines white, and occasionally some of the oral primaries are white.

Holotype: Reg. No. E. 464.

There are one hundred and forty-eight specimens of this little *Temnopleurus*, ranging in size from 5·5 × 3 mm. to 22 × 12 mm. There is considerable diversity in the form of the test, some individuals being so flattened that the height is little more than half the diameter, while others are more elevated, with the height exceeding two-thirds of the diameter. In one case the diameter is 16 mm. and the height 12 mm., but this specimen is somewhat deformed as a result of lateral pressure. There is considerable diversity in the abactinal system and in the pits and tubercles of the test; the ocular pores are not always slit-like, and may be quite evident; there is usually a pit at the proximal angle of each ocular plate, and this may be very conspicuous, but it is often entirely wanting; in one specimen, 19·5 mm. in diameter, ocular I reaches the periproct, but I have found no other specimen in which it even approaches such a condition; the pits in the test vary very much in size in different specimens, and there is also some diversity in the size of the primary tubercles. Diversity in colour is shown, due to the number of small spines and the purity of their whiteness; age is also a factor, for in small specimens the primaries are quite red at base, with no trace of violet, and there is no indication of green; these light-coloured little urchins, with nearly white tests and whitish spines, the larger ones with red on the basal half, look quite unlike the duller and darker adults, with their violet-red and green spines.

There is no doubt that this species is nearly allied to *T. reevesii*, but apparently the differences are constant. With the spines on, the colour alone distinguishes them easily. The bare tests may be distinguished by the smaller tubercles in *T. australis*, especially in the ambulacra in the midzone, and the more symmetrical abactinal system with the more completely exsert ocular I,

It is noticeable in many specimens of *T. australis* that the primary tubercle on an ambulacral plate in the midzone is of approximately the same size as, or not much larger than, the secondary tubercle at the inner end of the same plate, whereas there is a marked contrast in the sizes of the same tubercles in *T. reevesii*.

This species is apparently common on the coasts of South Australia, for while most of the specimens have no locality label, the following localities are represented: Spencer and St. Vincent Gulfs (Verco); Port Lincoln; Investigator Strait, 14 fathoms; Wallaroo Bay, 15 fathoms (Verco); Yankalilla Bay, 20 fathoms (Verco); St. Vincent Gulf; Backstairs Passage, 22 fathoms (Verco); between Trowbridge Lighthouse and Backstairs Passage. It is probable that *australis* extends its range to Western Australia, for there is very little doubt that the bare tests of a *Temnopleurus* which I recorded in 1914 ([50]) from Fremantle Beach are to be referred to this species; these tests are more brightly coloured than in any of the specimens before me, but that may be in part artificial.

## SALMACIS Agassiz.

### SALMACIS VIRGULATA var. ALEXANDRI.

*Salmacis alexandri* Bell, Zool. "Alert," 1884, p. 118.

*Salmacis virgulata* var. *alexandri* H. L. Clark, Cat. Rec. Ech. Brit. Mus., 1925, p. 88.

There are two specimens of this variety, one a bare and somewhat broken test, 57 mm. h.d., and the other a fine specimen, 47 mm. h.d., with primary spines 10 mm. long. The bare test is labelled "N. Territory," the other "N. East Australia." The two agree in the colouration of the test, and in the deep horizontal furrows so characteristic of the variety. The test is fundamentally white, and in the fine specimen is predominantly so; the spines too are pure white (possibly more or less bleached); the margins of all the horizontal furrows are light yellow-green, and the whole of the abactinal system and the adjoining coronal plates are of the same shade. In the bare test the green is more plentiful, and below the ambitus the general colour is light green with white tubercles.

## MICROCYPHUS Agassiz & Desor.

### MICROCYPHUS ANNULATUS.

Mortensen, Dansk. Selsk. Skr., (7) i, 1904, p. 101.

There are fifteen specimens of this lovely little sea-urchin, all taken by Dr. Verco; one is from Investigator Strait, 14 fathoms, while all the others are

([50]) Rec. W.A. Mus., i, 1914, p. 164.

from Spencer or St. Vincent Gulf; in only one case, however, is the depth given, and that one is from 20 fathoms. The specimens range in size from 12 x 10 mm. to 19 x 16 mm. or 19 x 17·5 mm.; the lowest specimen is 13 x 9·5 mm. Some of the specimens are darker than others, the test and basal part of the small spines being of a deeper shade, but on the whole the colouration is very constant. The primaries are pure white distally, a less pure shade basally; the coloured ring on the proximal half of the spine is very bright red distally, but is more or less dull, and often brownish or even greenish proximally.

## MICROCYPHUS COMPSUS.

H. L. Clark, Mem. M.C.Z., xxxiv, 1912, p. 322 (as a substitute for *M. elegans* Mortensen, preoccupied).

There are five bare tests of a *Microcyphus* which seem to represent this species. Of these, one from Spencer Gulf is 15 mm. h.d., and rather more than 13 mm. high; it is perfectly symmetrical, with a circular ambitus, and is in fine condition; the colour is dull rose-red, becoming dusky brown on the tubercled portion of the plates, while the tubercles themselves are a dirty greenish-white; this specimen is labelled *M. zigzag*. Another specimen, from St. Vincent Gulf, is similar in colour, but is duller; it is 11 x 9 mm., and lacks the entire abactinal system. Specimens dredged in 60 fathoms off Cape Borda, Kangaroo Island, and in 130 fathoms off Cape Jaffa, by Dr. Vereo, are a trifle larger than this, lack the abactinal system, have holes in the test, and are so light coloured, with only a rosy tinge on the bare portions of the plates, that they are probably much bleached. The smallest specimen, 8 x 6 mm., dredged by Dr. Verco in Backstairs Passage, 23 fathoms, is in good condition, and is notable for its colouration; the red is not at all "rosy," and the tubercled part of the plates is much lighter (instead of darker, as usual) than the red bare portion. On the whole this individual raises the question whether *compsus* and *zigzag* may not intergrade in colour, at least when young.

## MICROCYPHUS PULCHELLUS ([51]) sp. nov.

Test 12·5 mm. in diameter, 11 mm. high; abactinal system, 2·75 mm. across, with periproct about 1·50 mm.; peristome, 4·5 mm. in diameter. Test wholly bare, with no trace of spines, pedicellariae, or buccal membrane. Oculars all exsert; genitals each with two large tubercles on inner margin, excepting the rather conspicuous madreporite, which has only one, and that at the corner; periproct with numerous small, round plates (mostly missing); one, adjoining genital 3, is noticeably the largest of those present. Coronal plates seventeen

([51]) *Pulchellus*=beautiful in reference to the very fine colouration.

or eighteen in a column, commonly with one large primary tubercle and four or five small secondaries, of which three are on the outer half; the bare interambulacral space is narrow, and the uppermost plates have a small tubercle located in it. Ambulacral plates twenty-seven or twenty-eight in each column, each with a primary tubercle near middle, and some seven or eight very small tubercles in two horizontal series on outer half of plate; inner half of plate bare and smooth in midzone, but rarely with a very small tubercle near upper margin; poriferous areas broad (narrow at peristome), equalling half the plates; interporiferous tubercles so small as to be insignificant. Interambulacra are nearly 4·5 mm. wide in midzone; ambulacra scarcely 4 mm.

a b

Fig. 139. *Microcyphus pulchellus:* a, aboral view; b, side view of holotype (x 2).

Margins of all test plates, except near peristome, broadly white; entire surface of all the uppermost coronal plates white with a reddish tinge; lowermost plates and central portion of the others (except uppermost) rich reddish-brown; upper ends of ambulacra dull reddish-brown, merging into the greyish-brown of the abactinal system.

Holotype: Reg. No. E. 628.

There is but a single specimen of this striking form, a bare test from Spencer Gulf. Its colouration is so different from that of any other *Microcyphus* I have ever seen, I do not doubt that it represents a distinct species. But it must be admitted that large series of specimens of *Microcyphus* may show that the colour differences, which with our scanty material seem so useful, are really neither so important nor so constant as could be desired.

## MICROCYPHUS ZIGZAG.

Agassiz and Desor, Ann. Sci. Nat. (3), vi, 1846, p. 358.

A little, bare test of a *Microcyphus*, 10 mm. h.d. and 8·5 mm. high, seems to be a young individual of this species. The inner half of the plates in both ambulacral and interambulacral areas is dark yellow-brown, while the outer half is light flesh-red; the tubercles in both areas are a light, dingy cream-colour. This specimen was taken by Dr. Verco in 23 fathoms of water in Backstairs Passage.

## AMBLYPNEUSTES Agassiz.

### AMBLYPNEUSTES FORMOSUS.

Valenciennes, Voy. "Venus," Zooph., 1846, pl. ii, fig. 2.

There are four small *Amblypneustes*, which must be referred to this species, but they do not make its validity any more certain. They range in size from 7 x 5·5 mm. to 16 x 15 mm., and agree in having bright red primary spines, small, white periproctal plates, carrying no spinelets, and dark brown rhomboidal areas at the outer ends of the coronal plates. The ground colour of the test ranges from light fawn-colour to brown. The characteristic zigzag lines are more or less well developed on the bare interambulacral areas. The specimens are all from Dr. Verco's collections in Spencer and St. Vincent Gulfs.

### AMBLYPNEUSTES OVUM.

*Echinus ovum* Lamarck, Anim. s. Vert., iii, 1816, p. 48.
*Amblypneustes ovum* Agassiz, Mon. Ech. Anat. Echinus, 1841, p. ix.

There are thirty-six specimens, either without locality labels or from the Verco collections in St. Vincent and Spencer Gulfs, which I am referring to the typical form of this species, and few of them give any cause for hesitation. A specimen 31 mm. h.d. is only 25 mm. v.d., its height being thus only ·80 of its diameter, but the tuberculation and the general colouration and appearance do not warrant assigning it to either of the varieties. The specimens range in size from 11·5 x 10 mm. to 62 x 57 mm.; aside from the one just mentioned the lowest is 37 x 31 mm., or ·84, while the highest is 40 x 47·5 mm., or 1·19. In nearly every specimen, whether dry or alcoholic, the test is greyish-green, the spines more or less pale green or greenish-white, and the tube-feet darker than the test. Even in the smallest specimens, spinelets (at least one or two) can be found on the thick, periproctal plates. One specimen, 20 x 13 mm., is curiously deformed, resembling *Echinostrephus* in its rounded pentagonal ambitus, which if not actually above the equator is nearly so; the periproct is also unnaturally elevated.

After repeated study of all the *Amblypneustes* in this collection, I am unable to improve on the grouping adopted in the British Museum catalogue [52], but I do not for a moment suppose that that grouping expresses the true interrelationships of the various forms. Only much larger collections, with exact field-notes, can give us the light we need.

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[52] H. L. Clark, Cat. Rec. Ech. Brit. Mus., 1925, p. 28.

### AMBLYPNEUSTES OVUM var. GRANDIS.

*Amblypneustes grandis* H. L. Clark, Mem. M.C.Z., xxxiv, 1912, p. 329.
*Amblypneustes ovum* var. *grandis* H. L. Clark, Cat. Rec. Ech. Brit. Mus., 1925, p. 99.

There are two fine specimens from St. Vincent Gulf which certainly represent this variety. In one the height (62 mm.) is ·82 of the diameter (75 mm.), but in the other, which measures 89 x 61 mm., it is only ·69. This specimen is the largest *Amblypneustes* recorded. It has the test dark grey-brown (darkest near abactinal system), and the primary spines are pale red. The smaller specimen is somewhat lighter coloured, with the primaries a very pale red.

### AMBLYPNEUSTES OVUM var. PACHISTA.

*Amblypneustes pachistus* H. L. Clark, Mem. M.C.Z., xxxiv, 1912, p. 327.
*Amblypneustes ovum* var. *pachista* H. L. Clark, Cat. Rec. Ech. Brit. Mus., 1925, p. 99.

This is a heterogeneous lot of eighteen *Amblypneustes*, ranging in size from 7 x 4·5 mm. to 41 x 33 mm., and in colour from the green and grey shades of typical *A. ovum* to the brown and red shades of *A. formosus*. To be sure, no specimen has the colour markings of *A. formosus*, nor are the spines so deep a red, but the red is sufficiently conspicuous to make the contrast with *A. ovum* striking. The only features that these specimens have in common are a relatively low test, coarse tuberculation, and spinelets on the periproctal plates. A specimen 20 mm. in diameter is only 12·5 mm. high, while another 21·5 mm. h.d. is 17 mm. high; this range of height from ·62 to ·79 h.d. is illustrative of the heterogeneity of the variety. A specimen 8 x 5·5 mm. has the primary spines bright violet, and there is room for doubt as to whether it ever had spinelets on the periproct, but it is certainly much nearer *A. pachista* in form and general appearance than it is to any other described variety. It is not unlikely that some of the specimens here referred to *A. pachista* are really young *A. grandis*, but at present we know too little about growth changes and local varieties in the genus to enable us to determine that. Hence the variety *A. pachista* becomes a dumping place for all *Amblypneustes* which have spinelets on the periproct and the height less than ·80 h.d., and a colouration unlike typical *ovum*. Practically all of the present lot lack locality labels, but a few are undoubtedly from Spencer or St. Vincent Gulf.

### AMBLYPNEUSTES PALLIDUS.

*Echinus pallidus* Lamarck, Anim. s. Vert., iii, 1816, p. 48.
*Amblypneustes pallidus* Valenciennes, Voy. "Venus," Zooph., 1846, pl. ii, fig. 1.

There are sixty-nine specimens of this species, usually recognizable with ease, but thirty-nine are very small (2·5 mm. to 6 mm. h.d.). These little ones were dredged by Dr. Verco in St. Vincent and Spencer Gulfs, and are of no little interest because of their form and colour; all are relatively low (v.d. equalling ·52 to ·59 h.d.), which seems to indicate that the tendency to a spherical form so noticeable in *Amblypneustes* and *Holopneustes* is not at all a retention of a primitive condition, but is a recently acquired specialization. The colour of these young individuals is like that of the adults, either pale green or purple of some shade; twenty-two of the thirty-nine are predominantly green, eleven are predominantly purple (violet or deep lavender), and six are intermediate. In both adults and young the small spines are generally lavender, even when the primaries are purple or lavender, but occasionally they are pale green; primaries are usually unicolour, either green or purple, but occasionally they are green becoming violet at tip.

The adult specimens are all without locality labels, and twelve of them are bare tests. They do not show much diversity of form, for the lowest is 28 x 25 mm., and the highest is 48 x 50 mm.; v.d. is thus from ·90 to 1·04 h.d. In several large specimens the ambitus is distinctly above the equator, giving the test an egg-like form that is very noticeable.

## HOLOPNEUSTES Agassiz & Desor.

### HOLOPNEUSTES INFLATUS.

A. Agassiz, Bull. M.C.Z., iii, 1872, p. 56.

There are fourteen dry specimens of this species, of which nine are bare tests; none of the other five is fully covered with spines. In size they range from 17 x 15 mm. to 63 x 61 mm. In the largest specimen the ambulacra are 17 mm. wide, and the interambulacra are 21 mm., but in another individual with ambulacra 17 mm. wide, the interambulacra are only 18 mm. There is not a great deal of diversity in the form of the test, for it is notably high, even in the small specimens, and one 32 mm. in diameter is actually 34·5 mm. high, with the ambitus above the equator. In colouration there is considerable range, the tests being light greenish-grey, or bluish-grey, or dull reddish (with poriferous areas dull but light yellowish-green), or dull violet. The primary spines are usually violet of some shade, but they may be dull rose or pale red, or even dingy white. Apparently no two of the specimens are exactly alike. There are no locality labels for any of the specimens.

### HOLOPNEUSTES POROSISSIMUS.

Agassiz & Desor, Ann. Sci. Nat. (3), vi, 1846, p. 364.

Only four of the sixteen dry specimens representing this species have a

locality label, and that reads "St. Vincent Gulf." These four are the smallest ones; three are still clothed with their brilliant red spines; the fourth and smallest is nearly bare, and measures 27 x 27 mm., but it is not spherical, for the oral surface is flattened and the ambitus is above the equator; in these specimens the test is dull grey-green, the small spines and the basal part of a few primaries green, and the dried tube-feet white in marked contrast.

Of the other specimens five are still more or less clothed with spines; the tests are dark grey, more or less strongly tinged with green; the small spines are green, greenish, or pale grey sometimes tipped with red; the primaries are more or less bright red, with the basal part often more or less green; as a rule the spines of the oral surface are most nearly completely red. One of these specimens is 75 mm. h.d., but only 56 mm. v.d.; it is thus unusually low, with v.d. only ·74 h.d. A second specimen, 75 mm. h.d., is 66 mm. high, while a specimen 69·5 mm. h.d. is 68 mm. high. One specimen is markedly conical, while several are nearly spherical. The bare tests call for little comment but one is 77 x 70 mm. The excess of width of the ambulacra over the interambulacra increases with age; in the small specimens we find the proportions, ambulacra 8·5 mm., interambulacra 8 mm., and amb. 11·5 mm. int. 10 mm.; in larger specimens, with amb. 21 mm. across, int. is 15 or 16 mm.; in the largest specimens amb. is 27 mm. to 28 mm., and int. is 20 mm.

## FAMILY ECHINIDAE.

### TRIPNEUSTES Agassiz.

### TRIPNEUSTES GRATILLA.

*Echinus gratilla* Linné, Sys. Nat., ed. X, 1758, p. 664.
*Tripneustes gratilla* Lovén, Bih. Svensk. Vet-Akad. Handl., xiii, 1888, p. 77.

A single, bare test, 120 x 68 mm., labelled "East Australia," is the only representative of this species in the collection.

## FAMILY STRONGYLOCENTROTIDAE.

### PACHYCENTROTUS H. L. Clark.

### PACHYCENTROTUS AUSTRALIAE.

*Sphaerechinus australiae* A. Agassiz, Bull. M.C.Z., iii, 1872, p. 55.
*Pachycentrotus australiae* H. L. Clark, Mem. M.C.Z., xxxiv, 1912, p. 349.

A very nice series of this little-known sea-urchin contains eighteen specimens, ranging from 11 x 6 mm. to 38 x 24 mm.; there are five bare tests, but the remaining thirteen specimens are in fine condition. The largest individual

is from the north Coast of Kangaroo Island, the others are all from either St. Vincent or Spencer Gulf. In the smallest specimen ocular I is fully insert, but ocular V is barely so. In all the others both I and V are fully insert, and in two cases (individuals 33 mm. and 35 mm. in diameter) ocular II is also insert. It seems probable that having I, V, II insert is the normal progressive variation for *Pachycentrotus*, but it is not frequent enough to make it the species character for *australiae*.

In the matter of coloration there is a most interesting parallelism between the sea-urchin and the quite unrelated *Amblypneustes pallidus*, for just as in that species, some individuals are wholly green, others are wholly purple or violet, and others are partly green and partly violet. At one extreme in *P. australiae* we have specimens with the test grey above, becoming whitish orally, more or less markedly shaded with violet, primary spines bright violet, darkest at base, white-tipped, with one or more narrow rings of a darker violet faintly indicated or sometimes well marked, and small spines wholly white or white with a violet base; there is no green indicated anywhere. At the other extreme are specimens with the test greyish green, primary spines dull green, darkest at base, white-tipped, with one or more narrow rings of a dusky green faintly indicated or sometimes well marked, and small spines whitish, more or less green at base, and usually tinged with greenish; the only traces of violet are on the basal part of some small spines near the mouth. In both violet and green specimens the tubercles and the plates on the buccal membrane are white. Most specimens are intermediate between these two extremes; often the primary spines are more or less violet, with the basal part dull green, the tip white, and the encircling rings dark violet, dusky, or greenish; violet tends to be more in evidence orally and green aborally. In some specimens the predominating tone is brown, with a more or less evident greenish tinge, and some small individuals look quite brown and white; such specimens, however, when critically examined show traces of either violet or green, or both.

This is one of the most distinctive sea-urchins endemic on the southern coast of Australia, and it is a pleasure to note that it is apparently rather common in St. Vincent Gulf.

## HELIOCIDARIS Agassiz & Desor.

### HELIOCIDARIS ERYTHROGRAMMA.

*Echinus erythrogrammus* Valenciennes, Voy. "Venus." Zooph., 1846, pl. vii, fig. 1.

*Heliocidaris erythrogramma* Agassiz & Desor, Ann. Sci. Nat., (3) vi, 1846, p. 371.

This common species is represented by forty-three specimens, of which thirty-five are bare tests. The smallest are 2·75 mm. to 3 mm. in diameter, with seven coronal plates in a series, and the diameter of the peristome is considerably over half the test diameter. The largest is almost twenty-nine times as large (h.d. = 79 mm.), but it has only seventeen or eighteen coronal plates in a series, and the diameter of the peristome is only 24 mm., less than one-third h.d. Some smaller specimens have twenty coronal plates in a column, and the peristome but little more than one-fourth h.d. As for colour, we find the tendency to be either violet or green that *Pachycentrotus* and *Amblypneustes pallidus* show, but most specimens that are predominantly green have the basal portion of the spines more or less extensively violet or at least livid with a hint of purple.

One specimen, 67 mm. in diameter, is labelled *H. armigera*, and is certainly suggestive of that form; the primaries are only 20 mm. to 25 mm. long, but as they are less than 2 mm. in diameter they are not stout enough for *H. armigera*, which, however, is probably not a valid species, but only an extreme form of *H. erythrogramma*.

While many of the specimens are without labels, the following localities are represented in the present series: Wallaroo Bay, 15 fathoms; Investigator Strait, 14 fathoms; St. Vincent Gulf; "south-east coast of Australia"; "Outer Harbour," St. Vincent Gulf.

## FAMILY ECHINOMETRIDAE.

### PARASALENIA A. Agassiz.

### PARASALENIA PÖHLII

Pfeffer, Verhandl. Ver. Naturw. Unterh. Hamburg, vi, 1887, p. 110.

With the specimen of *Echinometra mathaei*, from Cairns, Queensland, there was a test of a *Parasalenia*, which is better referred to this species than to *P. gratiosa*, for there are no tubercles on the abactinal system, and the spines left around the peristome are pale violet with faint dusky bands. But genital three is not shut out from the periproct, and there is no red in the colouration. The abactinal system is greenish, but each genital plate is purple at the centre. The test is 16 mm. long, 13 mm. wide, and 7 mm. high. The colour of the test is nearly white, with some green next to the genital plates; the larger tubercles are pale lavender. There are five subequal anal plates, each one opposite an ocular. It is not altogether unlikely that this peculiar *Parasalenia* represents an undescribed species.

### ECHINOMETRA Gray.

### ECHINOMETRA MATHAEI.

*Echinus mathaei* de Blainville, Dict. Sci. Nat., xxxvii, 1825, p. 94.
*Echinometra mathaei* de Blainville, Dict. Sci. Nat., lx, 1830, p. 206.

There is a single small specimen of this common sea-urchin from Cairns, Queensland. The primary spines are pale olive at base, becoming darker distally and then abruptly white-tipped. The species belongs, as does *Parasalenia*, in the North Australian fauna.

### HETEROCENTROTUS Brandt.

### HETEROCENTROTUS MAMMILLATUS.

*Echinus mammillatus* Linné, Sys. Nat., ed. X, 1758, p. 667.
*Heterocentrotus mammillatus* Brandt, Prod. desc. Anim., 1835, p. 266.

There is a single small but handsome specimen from north-east Australia. The primary spines are short and very stout, with two broad but ill-defined white bands near tip; the ground colour is light grey-brown or fawn-colour, becoming dark brown distally, though the actual tip is brownish-yellow; a typical spine is 60 mm. long, 6 mm. thick at base, and 12 mm. near tip; orally the primaries are flattened and broadly tipped with orange-red or brownish-orange; secondaries deep chocolate-brown.

## ORDER EXOCYCLOIDA

## SUB-ORDER CLYPEASTRINA

### FAMILY ARACHNOIDIDAE.

### ARACHNOIDES Leske.

### ARACHNOIDES PLACENTA.

*Echinus placenta* Linné, Sys. Nat., ed. X, 1758, p. 666.
*Arachnoides placenta* Agassiz, Mon. Ech. Mon. Scut., 1841, p. 94.

There are five specimens of this well-known "sand-dollar," of which one, 34 x 34 mm., and water-worn, is from an unknown locality, while four are from Townsville, Queensland, "presented by Clement L. Wragge, August 5, 1886." These are all small specimens, 35 mm. to 48 mm. across; the largest is bare and broken.

## AMMOTROPHUS ([53]) gen. nov.

Test discoidal, its height less than ·15 of its diameter. Ambulacra wider than interambulacra at margin of test. Petals short, wide; poriferous areas divergent, the outer margin rounded, so that they appear curved inward at tip. Genital pores four. Periproct rather large, on oral surface, some distance from margin. Peristomal membrane heavily plated. Auricles entirely distinct, much more widely separated than in *Arachnoides*. Pedicellariae with three valves.

Genotype: *Ammotrophus cyclius* sp. nov. *(vide infra)*.

There is no doubt that this is the most interesting new genus of Echinoderms that has been discovered for some time, since it is not only so well characterized, but is obviously a member of a family which has always consisted of but a single genus. The character of the auricles, the plated buccal membrane, the four genital pores, the form of the test, and the character of the ambulacra leave no room for questioning the relationship to *Arachnoides*, while the form and position of the periproct, the pedicellariae, and certain details of the petaloid area serve to separate it well from that genus. It is noteworthy that the new genus is South Australian, while *Arachnoides* occurs from New Zealand and the north-eastern coast of Australia northward to the Malay Peninsula.

## AMMOTROPHUS CYCLIUS ([54]) sp. nov.

Test 54 mm. long, 54 mm. wide, and 7·5 mm. high, but the outline is not perfectly circular, for there is a slight indentation at the margin in each ambulacrum, and also in the posterior interradius; if measured through II–4 or IV–1, the diameter is only 53 mm. Petals approximately 15 mm. long by 8·5 mm. wide near the widely open tip; II and IV are a trifle longer than I and V, and III is, by an insignificant margin, the largest of all; there are about forty pore-pairs on a side in III. Abactinal system small, with the four genital pores close together. Ambulacral furrows conspicuous and very straight. Peristome irregularly circular, less than 3 mm. in diameter, the membrane filled with narrow, thick, curved plates; centre of peristome is 27 mm. from anterior margin of test. Periproct, 3·25 mm. long, 2·5 mm. wide, its membrane heavily plated, its centre 7 mm. from posterior margin of test.

Test covered with a dense coat of small spines, like those of *Arachnoides*, but not nearly so diversified: those of the dorsal side are relatively short (about 1 millimetre long), with the distal end swollen, slightly curved, and more or less

([53]) ἀμμότροφος=growing in sand, in reference to the habit indicated by the very flat test.

([54]) κύκλιος=circular, in reference to the ambital outline.

asymmetrical, one side being often flattened to some degree; on the oral side the spines are longer, especially about peristome and periproct, not swollen at tip, but generally blunt, though near test-margin they may be pointed; they are usually curved, but may be perfectly straight; there is no essential difference between those of different areas, except in size, the largest being near the margin in the interambulacra, the smallest along the sides of the ambulacral furrows; the latter do not in any sense "roof over" the furrows.

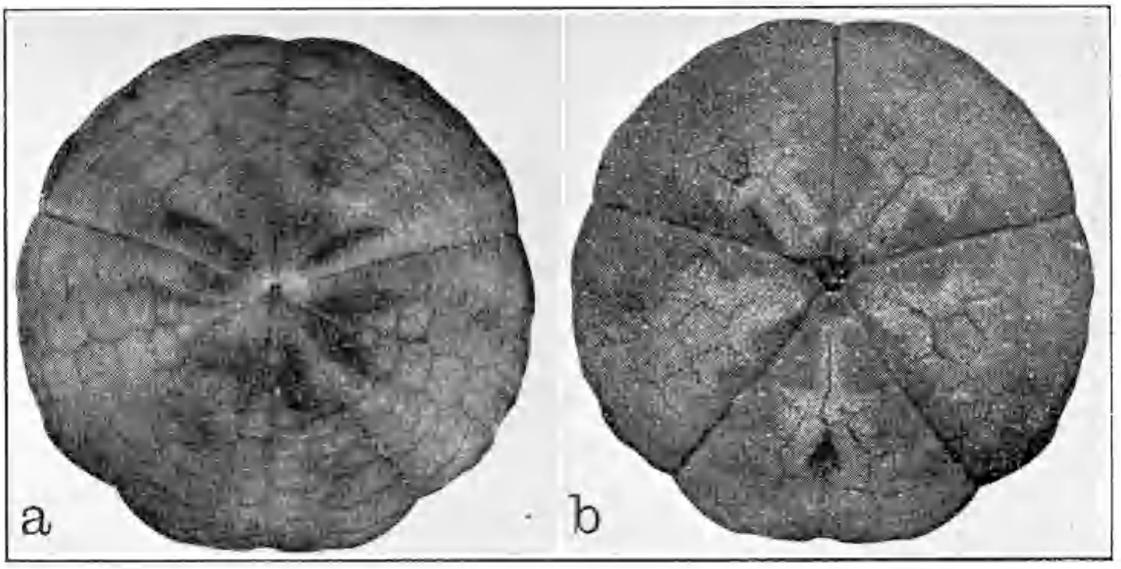


Fig. 140. *Ammotrophus cyclius*; a, aboral view; b, oral view of paratype (nat. size).

Pedicellariae so small, so few, and so hard to find that they can be of little service as a species character, but they are of great interest because so entirely different from those of *Arachnoides*. After prolonged search, I found six, of which one may be called triphyllous and the others tridentate; but the tridentate are of two quite distinct sorts. All the pedicellariae seen had three valves. The triphyllous had valves scarcely ·10 mm. long, with blades nearly straight, narrow, with nearly parallel sides, ending in a conspicuous sharp, inwardly curved, unpaired tooth. The tridentate have the heads about as long as the stalks, but only about ·20 mm. in length; the largest was about ·25 mm.; in one form the head is stout, long pyramidal, blunt, with valves somewhat flattened on the back, especially basally, and closely appressed to each other, along the finely serrate margins throughout their entire length; in the other form the heads are also stout and about ·20 mm. in length, but the valves are somewhat curved, and meet only for about the distal third; they thus resemble somewhat the tridentate pedicellariae of some Clypeasters; both kinds of tridentates in *Ammotrophus* thus seem to be of a relatively generalized type.

Colour of all the specimens, whether dry or alcoholic, is a rather bright yellow-brown, sometimes with a more or less evident reddish tinge.

Holotype: Reg. No. E. 644.

There are eighty-four specimens of this interesting sand-dollar, some of which had been identified as "*Echinarachnius parma*" and some as "*Peronella decagonalis*"; there is an obvious resemblance to *Echinarachnius*, and it is possible that the records of that genus from Australia are based upon specimens of *Ammotrophus*. Most of the specimens before me are from Encounter Bay, but a considerable number were dredged by Dr. Verco in St. Vincent and Spencer Gulfs. There is remarkable uniformity in the shape and proportions of the test; the smallest is 15 x 15 mm., with a height of less than 2 mm., while the largest is 59 x 59 x 8·5 mm. The indentations in the margin in the posterior interradius and in the ambulacra are about equally evident in young and old, but the smallest specimens have the periproct relatively nearer the margin than do the adults. Genital pores are not usually present until the individuals are nearly 30 mm. in diameter. The alimentary canal runs forward in ambulacrum III for a short distance (about to the end of the petal), then passes to the left into interambulacrum three, and runs around the body, in the vicinity of the petal tips on the left-hand side, but distal to them on the right-hand side, to the right-hand margin of III, where it bends abruptly inward, and then runs backward under the petal tips in II and I to V, where it bends outward, and passing over the outer loop joins the periproct. Its course is easily traced, through the test, in young, alcoholic specimens.

Examination of a perfectly clean bare test shows that the ambulacral furrows of the oral surface extend up over the margin, and run almost to the apical system, diminishing rapidly after they enter the petals, just as in *Arachnoides*, but quite different from any of the *Scutellidae*. The ambulacra at test-margin are about twice as wide as the interambulacra; ambulacra I and V are 23 mm. wide, in a test 50 mm. in diameter, the others 19 mm. to 20 mm.; interambulacra 1 and 4 are 9 mm. wide, the others 10 mm. to 11 mm. The primordial interambulacral plates are all in place around the peristome, as in *Arachnoides*, but just as in that genus the second series of ambulacral plates form a closed ring, separating the other interambulacral plates from the basicoronal series. The succeeding ambulacral plates are much smaller and widely separated interradially, so that there are three pairs of interambulacral plates in each interambulacrum on the oral side of the test; occasionally there are only two pairs in addition to the marginal plates, but much more commonly so much of the marginal plates is visible orally that we might say there are four pairs of oral interambulacral plates. This condition is interesting, because in *Arachnoides placenta* there is only one such pair, and in *A. zelandiae* there are two

(sometimes three), so that *Ammotrophus* is apparently less specialized than *Arachnoides*. At the other end of the interambulacrum, where it touches the apical system, the plates are very small and more or less coalesced, so that it is almost impossible to make out the sutures, but in young specimens they are detectable, and it is certain there is not a single adapical plate, as in the *Laganidae*.

Examination of the interior of the test shows that the oral and aboral surfaces are quite separate to the very margin, but the outer third of the interior space is well filled by concentric circles of calcareous pillars, which may coalesce more or less laterally. In each ambulacrum, just at the end of the petals, are two stouter sets of such pillars, also more or less coalesced, and in the interradii (on the large ambulacral plates of the second series) are still larger pillars, the innermost of which are just back of the auricles. The ambulacral plates of the basicoronal series, on which the auricles stand, may or may not be in contact to some extent at the peristomal margin of the interior of the test; in other words, the primordial interambulacral plates, which are fairly wide on the outer surface of the test, have bevelled lateral margins, and their inner surface may be so reduced proximally that they no longer separate the ambulacral plates there.

## AMMOTROPHUS PLATYTERUS (53) sp. nov.

Test 27 mm. long, 29·5 mm. wide, and 3·5 mm. high. Petals about 6 mm. long, nearly 5 mm. wide, with about thirty pore-pairs on each side; III is slightly the largest, II and IV the narrowest. Abactinal system very small, with four genital pores, the posterior pair much further apart than the anterior. Ambulacral furrows very well marked, except in III, where it is rather indistinct; the furrows run up on to the aboral side, as in *A. cyclius*; furrows II and IV are nearly straight, with only a slight curve near peristome, but furrows I and V are much curved; they run out from the peristome at nearly a right angle to the median line, and then bend downwards to the margin. Peristome posterior, 2·5 mm. long, 2 mm. wide; its centre is only 12 mm. from posterior margin of test. Periproct rounded diamond-shape, about as long as wide, 1·75 mm. in diameter; its centre is 3·5 mm. from posterior margin of test. In arrangement of plates in test and proportions of ambulacra and interambulacra, not essentially different from *A. cyclius*. Test perfectly bare, white.

Holotype: Reg. No. E. 645.

There is but a single specimen of this species from St. Vincent Gulf. It is superficially quite different from *A. cyclius*, and probably represents a distinct

(53) πλατύτερος=broader, in reference to the shape of the test as compared with *A. cyclius*.

species, but it is possible that it is only a "freak" *A. cyclius*. It is even possible that with larger series of *A. cyclius* available greater diversity in test-form will be discovered, and this specimen will prove to be only an unusually wide individual of the common species. It seems better to treat it as a distinct species until more abundant material determines its true status.

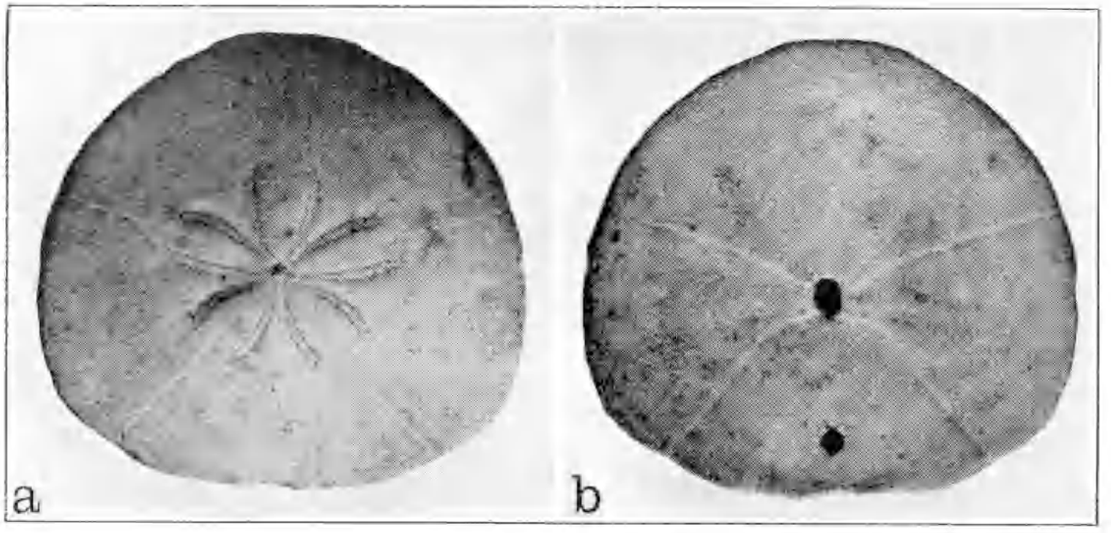


Fig. 141. *Ammotrophus platyterus;* a, aboral view; b, oral view of holotype (x 2).

## FAMILY LAGANIDAE.

### PERONELLA Gray.

### PERONELLA LESUEURI.

*Laganum lesueuri* Agassiz, Mon. Ech.: Mon. Scut., 1841, p. 116.
*Peronella lesueuri* A. Agassiz, Rev. Ech., pt. 1, 1872, p. 148.

There is only a single, bare test, 112 mm. long by 110 mm. wide, from an unknown locality.

### PERONELLA PERONII.

*Laganum peronii* Agassiz, Mon. Ech.: Mon. Scut., 1841, p. 123.
*Laganum (Peronella) peronii* Gray, Cat. Rec. Ech. Brit. Mus., 1855, p. 13.
*Peronella peronii* A. Agassiz, Rev. Ech. pt. 1, 1872, p. 149.

Although there are 132 specimens of this characteristically Australian species in the collection, not a quarter of them have their normal coat of spines and more than two-thirds are dead, bare tests, often damaged. Specimens, living when taken, are from Dr. Verco's collections in Spencer and St. Vincent Gulfs, but there are dead tests from the following localities, most of which were

dredged by Dr. Vereo: Off Beachport, 110–200 fathoms: Kangaroo Island, off Cape Borda, 62 fathoms; K.I., off Point Marsden, 17 fathoms; K.I., off American River, 8 fathoms; off Yankalilla Bay, 20 fathoms; 35 miles south-west of Neptune Island, Investigator Strait, 104 fathoms; Backstairs Passage, 20–22 fathoms; off Cape Jaffa, 90 fathoms; 60 miles west of Eucla, Great Australian Bight.

The specimens range in size from less than 2 mm. in length to something over 22 mm. Genital pores are evident in some specimens 12 mm. long, but there is great individual diversity in this matter; in one specimen 6 mm. long the four genital pores are conspicuous while in another almost 12 mm. long there are none visible. Madreporic pores usually begin to appear when the test is 5–6 mm. long, but they are never very numerous or conspicuous, and the oculo-genital mass (the apical system) is more completely obscured than in any other echinoid I have examined.

## FAMILY FIBULARIIDAE.

### ECHINOCYAMUS Leske.

### ECHINOCYAMUS PLATYTATUS.

H. L. Clark, Mem. M.C.Z., xlvi, 1914, p. 63.

Although there are 168 specimens of this species at hand, not one was alive when taken so far as can be told from present appearances; only four show any spines at all and in these, the indications are that the tests were dead and the spines were falling off when they were dredged. The largest specimen is 9·5 x 8 mm., while the smallest are about 2 mm. long. There is great variation in form, some individuals being as wide as long and practically circular in outline while others are only three-fourths as wide as long, and the anterior end is narrower and bluntly pointed. The height ranges from about ·23 of length to over ·32, but usually it is well under ·30. There is great diversity also in the matter of the genital pores, which may be very large or moderate or small; there is no correlation between the size of the test and the size of the pores; some very small specimens have big pores and some of the largest specimens have small pores; there is probably a sex correlation but that is at present a pure assumption. There are normally four pores but it is not uncommon to find but three and one individual, nearly 6 mm. long, has but two, one in interradius 1 and one in 3; they are relatively very large.

This large series of specimens is from the following localities: Off Cape Jaffa, 130 fathoms; off Beachport, 110–200 fathoms; Backstairs Passage, 17–22 fathoms; off St. Francis Island, 15–20 fathoms; St. Vincent Gulf; King George's Sound, 12–25 fathoms; beach at Hopetown, West Australia. Practically all the specimens were collected by Dr. Vereo.

## FIBULARIA Lamarck.

### FIBULARIA CRANIOLARIS.

*Echinocyamus craniolaris* Leske, Add. ad Klein, 1778, p. 150.
*Fibularia craniolaris* de Blainville, Dict. Sci. Nat., xvi. 1820, p. 512.

There are 305 fibularias, which I am including under this name but their diversity of form is very great, as is also the diversity of size. They were taken at the following places, chiefly by Dr. Vereo: Yankalilla Bay, 20 fathoms; Investigator Strait, 20 fathoms; Backstairs Passage, 17–22 fathoms; off Point Marsden, Kangaroo Island; off Cape Marsden, 17 fathoms; St. Vincent Gulf; east of North Neptune, 45 fathoms; Spencer and St. Vincent Gulfs; King George's Sound, 12–25 fathoms. Only nine or ten still carry their spines.

The smallest are about 2·5 mm. long and less than 2 mm. wide, only moderately well-arched, and with bluntly pointed ends, especially anteriorly. Larger specimens show an increasing variety of form and the large ones are often strikingly unlike; thus one specimen is 9 mm. long, almost 8 mm. wide and 7 mm. high, while another is 11·5 mm. long, almost 8 mm. wide and 6·5 mm. high. some individuals are somewhat flattened dorsally while others tend to be conspicuously elevated in ambulacrum III in front of the apical system. In spite of this diversity of shape there is such complete agreement in the small periproct placed close behind the peristome, the small genital pores and the large ambulacral pores, forming short petals with few pore-pairs, that I do not hesitate to call all of the specimens *F. craniolaris*.

### FIBULARIA PLATEIA ([56]) sp. nov.

Test 6·25 mm. long, 4·8 mm. wide and 2·35 mm. high, somewhat higher anteriorly than posteriorly. Petaloid area about 3·25 mm. long by 2·5 mm. wide; pores of petals big, as large as genital pores, two very oblique pairs on each side of each petal but in petal IV, the two pairs in the anterior area each lacks one pore so there are but six pores in petal; in petal II one of posterior pairs lacks a pore so there are but seven pores in petal; there are thus thirty-seven pores in the whole petaloid area instead of the forty that there should be. Genital pores four, large. Ocular pores not detectable. Madreporic pore single. Peristome 1·25 mm. in diameter, its centre 3 mm. from posterior margin of test. Periproct ·80 mm. in diameter, its centre 1·25 mm. from posterior margin of test; the piece of test between peristome and periproct is thus only a trifle over half a millimeter wide. Test perfectly bare, whitish.

Holotype: Reg. No. E. 650.

([56]) πλατεῖα = flat, in reference to the low Echinocyamus-like test.

The holotype is the only adult individual among the 159 specimens of *Fibularia* that I am referring to this species. The others range from less than two to a little over four mm. in length. There is not much diversity in the shape of the test which is always flattened but there is much diversity in the number of pores in the petaloid area, ranging from thirty-one to thirty-nine in the larger specimens and being much fewer than thirty in the small ones. The genital pores are often much larger than the ambulacral pores. There is no trace of dividing

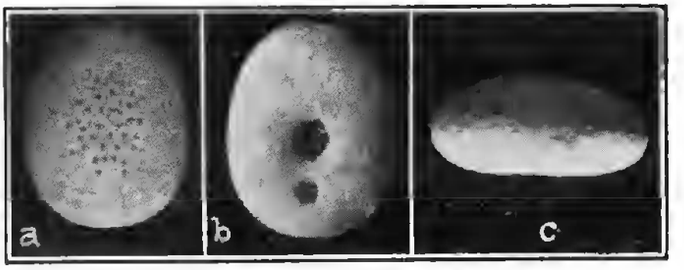


Fig. 142. *Fibularia platcia*; a, aboral view; b, oral view; c, side view of holotype (x 1).

partitions in the interior of the test, the species being a true Fibularia in spite of its flattened test. It is nearest, perhaps, to the East Indian species *F. cribellum* but the differences in the form of the test and in the petaloid areas seem to me too great to permit considering them identical. But I have never seen *F. cribellum* and it may be comparison of specimens will show that I am wrong in making a new species of the South Australian form. Nearly all of this large series of *F. plateia* we owe to Dr. Verco. They were taken at the following places and it will be noticed that this *Fibularia* occurs, apparently, with *F. craniolaris* and *Echinocyamus platylatus*: Off Beachport, 40–110 fathoms; Backstairs Passage, 17–22 fathoms; seven miles south-west of Newland Head, outside Backstairs Passage, 20 fathoms; Wallaroo Bay, 15 fathoms; St. Vincent Gulf; off St. Francis Island, 15–20 fathoms; off Cape Borda, 55 fathoms; off Cape Jaffa, 130 fathoms; east of North Neptune Island, 45 fathoms; off Bunbury, West Australia, 22 fathoms. All the specimens are bare, dead tests.

## SUB-ORDER NUCLEOLITINA

### FAMILY NUCLEOLITIDAE.

#### APATOPYGUS Hawkins.

#### APATOPYGUS RECENS.

*Nucleolites recens* Milne-Edwards, Cuvier's Reg. Anim.; Zoophytes. 1836, pl. xiv, fig. 3.

*Apatopygus recens* Hawkins, Geol. Mag., lvii, 1920, p. 396.

One of the most interesting specimens in the collection is a young *Apatopygus* taken by Dr. Verco in 22 fathoms off Bunbury, West Australia. The specimen is 10 mm. long, 8 mm. wide and 4 mm. high, and is covered with a complete coat of spines and pedicellariae, showing that it was living when taken. The genus is known at present only from New Zealand, though it has been recorded also from Madagascar. This specimen which is undoubtedly from West Australia makes the Madagascar record more credible. I have no specimen from New Zealand small enough to make a satisfactory comparison with the present specimen possible but fortunately Mortensen ([57]) has given so full and clear an account of the New Zealand species (*A. recens*) that it is not difficult to see wherein the West Australian resembles or differs from it. The resemblances are many, the differences few and trivial. The only difference that is worth mentioning is in the pedicellariae which are fairly abundant and in general correspond to Mortensen's description and figures. There are about fifty globiferous pedicellariae present chiefly along the sides of the test and as the glandular tissue on the heads of these has dried black (or nearly so), each pedicellaria appears as a black spot among the pale yellowish spines. The valves of these pedicellariae are not exactly like those of the New Zealand form, as the blade is a little longer, more constricted and has but four terminal teeth. The tridentate pedicellariae also show some slight differences due to the greater thickness of the basal part: the valves seem to be distinctly wider basally. Although these differences seem trivial, they at least suggest the possibility that the West Australian *Apatopygus* is not identical with the New Zealand species but represents a new species. In view however of the scantiness and youthfulness of the material, it is best to call it *A. recens* until abundant material shall solve the problem.

## SUB-ORDER SPATANGINA

### FAMILY HEMIASTERIDAE.

#### PROTENASTER Pomel.

#### PROTENASTER AUSTRALIS.

*Desoria australis* Gray, Ann. Mag. Nat. Hist. (2), vii, 1851, p. 132.
*Protenaster australis* Pomel, Class. Meth. Ech., 1883, p. 36.

A small, bare test, 21 mm. long, 18 mm. wide, and 13 mm. high, of this species is of interest because of its locality. It bears the label: "Collected on beach at Ellensbrook, w. coast of W. Australia, south of Cape Naturaliste. Dr. Verco."

([57]) Mortensen, Vid. Med., lxxiii, 1921, pp. 184-192, pl. viii.

## FAMILY SPATANGIDAE.

### GONIMARETIA H. L. Clark.

### GONIMARETIA INTERRUPTA.

*Lonchophorus interruptus* Studer, Monatsb. Berlin Acad. Wiss., 1880, p. 880.
*Gonimaretia interrupta* H. L. Clark, Mem. M.C.Z., xlvi, 1917, p. 245.

A specimen of this rare species is in the collection, but has no locality label. The only specimen previously known is the unique holotype in Berlin, which was taken in "30 fathoms, West Australia." Presumably, therefore, the present specimen is from the western coast of the continent. It is 26 mm. long, 22 mm. wide, and 12 mm. high; the abactinal system is only 11 mm. from the anterior end, and the test is highest there. In side view, therefore, the form of the test looks very different from that of *G. tylota*, the most nearly allied species of *Gonimaretia*. The specimen is an interesting non-pentamerous variant, as there is no petal in ambulacrum I; ocular I seems to be absent, and ambulacrum I ends just above the ambitus in the zone where the petal, if present, would begin. Interambulacra 1 and 5 are both present, clear to the apical disk, but column 2 of area 5 just fails to reach the disk. Petals II, IV, and V are each about 8 mm. long. The specimen is pentamerous ventrally. It belongs in Jackson's Group 16, and is discussed by that author in his recent memoir (58).

The pedicellariae of this species have never been described, so it is of interest to compare them with those of *G. tylota*. Globiferous pedicellariae are common on the ambulacra orally, as in *G. tylota*, but they are conspicuously different, for the valves are much shorter and less slender, and the tips are not coloured; in the present specimen the valves are nearly or quite closed, not spread wide open, as in the specimen of *G. tylota* examined, but this is, of course, a matter of preservation, or at least of physiological condition. Tridentate pedicellariae are all of the narrow-valved type of *G. tylota;* none resembling a rostrate type were seen; the valves are shorter and broader than in *G. tylota*, but are not very distinctive. Ophicephalous pedicellariae of normal form are present, but seem to be rare; no triphyllous pedicellariae were seen.

In only one respect does this specimen differ essentially from Studer's original description and figures, and that is in the presence of primary spines on the aboral surface. Studer's specimen seemed to have none, but in the present individual there are four in interambulacrum 2, near the apical system, close to the boundary of ambulacrum II, and two, or perhaps three, in the same relative position in interambulacrum 3. These primaries are not so large as in *G. tylota*, and their position is entirely different from those of that species.

(58) Mem. Boston Soc. Nat. Hist., viii, 1927, p. 536.

There can be no doubt that the species is a typical *Gonimarella*, and it is a great pity that we have no information as to when and where the present specimen was taken.

### BREYNIA Agassiz & Desor.

### BREYNIA AUSTRALASIAE.

*Spatangus australasiae* Leach, Zool. Misc., ii, 1815, p. 68.
*Breynia australasiae* Gray, Cat. Rec. Ech. Brit. Mus., 1855, p. 46.

There are seven bare tests of this common Australian spatangoid, of which four are from Port Essington, Northern Territory, and the others are without labels. The smallest specimen is 45 mm. long, 39 mm. wide, and 28 mm. high; the largest is 75 x 62 x 38 mm.

### ECHINOCARDIUM Gray.

### ECHINOCARDIUM CORDATUM.

*Echinus cordatus* Pennant, Brit. Zool., iv, 1777, p. 69.
*Echinocardium cordatus* Gray, Brit. Rad., 1848, p. 6.

There are eighty-eight specimens of this cosmopolitan species, but the great majority are small and of little interest. Those which have locality labels were collected at the following places: Off American River, Kangaroo Island; Port Willunga, S.A., A. Zietz coll.; Warooka, Yorke Peninsula; off Yankalilla Bay, 20 fathoms; St. Francis Island, 15–20 fathoms; St. Vincent and Spencer Gulfs, Vereo collection. The specimen from Warooka is a bare test, 53 mm. long, 48 mm. wide, and 33 mm. high, while that from American River, which is completely bleached and considerably broken, is 57 x 52 x 37 mm. These two specimens are considerably larger than any non-European individuals of this species that have been recorded. On comparing them with European specimens of similar size I was at once struck by three differences, and for a time I thought I had found tangible characters by which to distinguish *E. australe* as a species distinct from *E. cordatum*. The three points were first the size and width of the area comprised within the internal fasciole; second, the number of pore-pairs enclosed within the subanal fasciole; and third, the form of the periproct. The South Australian specimens have the area within the internal fasciole relatively small and narrow; the specimens with which I first compared them have it large and notably broad. The Australian specimens have four pore-pairs on each side of the subanal plastron, the European specimens only three. The Australian specimens have the periproct as wide as high, the European specimens have it much higher than wide. But further comparison of specimens convinced me that individual diversity is so great in the form and size of both internal

fasciole and periproct that those characters cannot be relied on. There is also intergradation in the number of subanal tube-feet, but here the difference between the northern and southern forms is worth noting. Many, perhaps most, Australian specimens over 25 mm. long, have four such tube-feet, and in one specimen there are five on each side. In European specimens I have only found one which had four, and occasionally there are only two, as in young specimens from everywhere. Japanese specimens have only three, so far as my observations go. Of five New Zealand specimens two have two, two have three, and one has four. Evidently we cannot distinguish a species on so variable a character, but I have not sufficient material to enable me to decide whether we might not wisely recognize a southern variety or subspecies. However, it looks as though the Australian form was as different from that found in New Zealand waters as it is from the European species.